BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS

ASSOCIATION

ENGLISH EDITION

[656 .222.4 (.493) & 656 .23 (.493)]

THE BELGIAN RAILWAYS.

Their present and future capacity,

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Figs. 1 to 3, pp. 901 to 908.

The question whether or not a through canal, to be used by boats of 1 350 tonnes, ought to be cut between Antwerp and Liége was raised before the Belgian « Commission on major Public Works ».

The Commission was asked in particular to reply to the following question:

« Whether the development of the rail-« ways and of the new means for the bulk « carriage of merchandise by rail, forms « at least a partial solution of the prob-« lem posed, namely : Means of providing « for present and future traffic. » As we were delegated to represent the National Company before the Commission, we were led to investigate the capabilities of the Belgian Railways from the triple aspect of:

traffic cost prices and rates.

As the problems technical, economic, and financial, placed before the Commission, especially affected the Eastern half of the country, our investigation was directed towards that section (1).

FIRST PART.

Traffic.

In 1913 the Belgian Railways carried tons) of heavy goods: in 1927 they carried 66 million tonnes (64 950 000 English 76 (74 800 000 English tons). The aver-

⁽¹⁾ We naturally looked into the capacity of the navigable waterways, but the results of this part of our investigation need not be given here.

age distance hauled per tonne of goods was 86 km. (52.59 miles per English ton) in 1913: it rose to 103 km. (62.99 miles) in 1927, so that in this period the number of tonne-kilometres rose from 5.729 to 7.869 millions (from 3.503.7 to 4.812.4 million English ton-miles), that is, an increase of 37 %.

The number of trains, however, formed to carry this traffic fell from 787 000 in 1913 to 686 000 in 1927. If the average distance run by the trains increased from 45 to 46 km. (28 to 28.6 miles), the number of train-kilometres, 35 millions (21 748 000 train-miles) in 1913, none the less fell to 32 millions (19 884 000 train-miles) in 1927, which represents a reduction of 10 %.

This result is due to the increase in the useful load of the trains which rose from 173 to 277 t. (170.3 to 272.6 English tons) (1).

Briefly, the Belgian railways carried, in 1927, 37 % more tonne-kilometres than in 1913 with 10 % train-kilometres less. This at once gives an idea of the progress that can be effected in the operation of a railway!

If we take the Belgian lines and if along each line we draw bands of width in proportion to the number of goods trains moving over it each 24 hours we get a diagram giving a very suggestive idea of the density of traffic (fig. 1).

The width of the black bands shew that in spite of its unsatisfactory profile, the Luxembourg line (Arlon, Jemelle, Namur) is one of the most heavily loaded of the system. It deals with, on the most congested section, 8 to 9 million net tonnes of traffic both directions being added together (2), although the movement of

goods trains is made difficult by the large number of passenger trains at different speeds run over it. The differences of speed between different trains over a line are an obstacle to intense operation, and consequently to the output of the line.

32. 31 - 2.1

It will already be realised from the simple examination of the diagram what an extraordinary development of traffic is possible on the lines in the North East of Belgium which are located with easier gradients, some even on the level, and are not run over by passenger trains at high speed.

1. What is the present traffic on the railways in the Eastern section of the country?

To answer this question, the diagram (fig. 2) has been prepared. This graph, coloured in the original, brings out very clearly the chief traffic currents in this area; we see especially:

- 1. Two heavy currents from the Grand Duchy of Luxemburg, from Alsace, from Lorraine and from the East of France towards Antwerp, one via Latour-Dinant-Ottignies, the other via Arlon-Jemelle-Namur-Ottignies. They amount together to 2550000 tonnes a year. In the opposite direction, 1470000 tonnes:
- 2. A current from Germany towards Antwerp via Montzen, of 720 000 tonnes a year. In the opposite direction, 480 000 tonnes:
- 3. Currents from the Liege district towards Antwerp by different routes, of 1 650 000 tonnes a year; in the opposite direction, 1 290 000 tonnes;
- 4. Currents from the Charleroi district towards Antwerp of 1 710 000 tonnes a year and 930 000 tonnes in the opposite direction;
- 5. Currents from the Campine in different directions : towards Liége

⁽¹⁾ Accessory carriage included.

^{(2) 50} trains \times 2 \times 300 days \times 300 net tonnes.

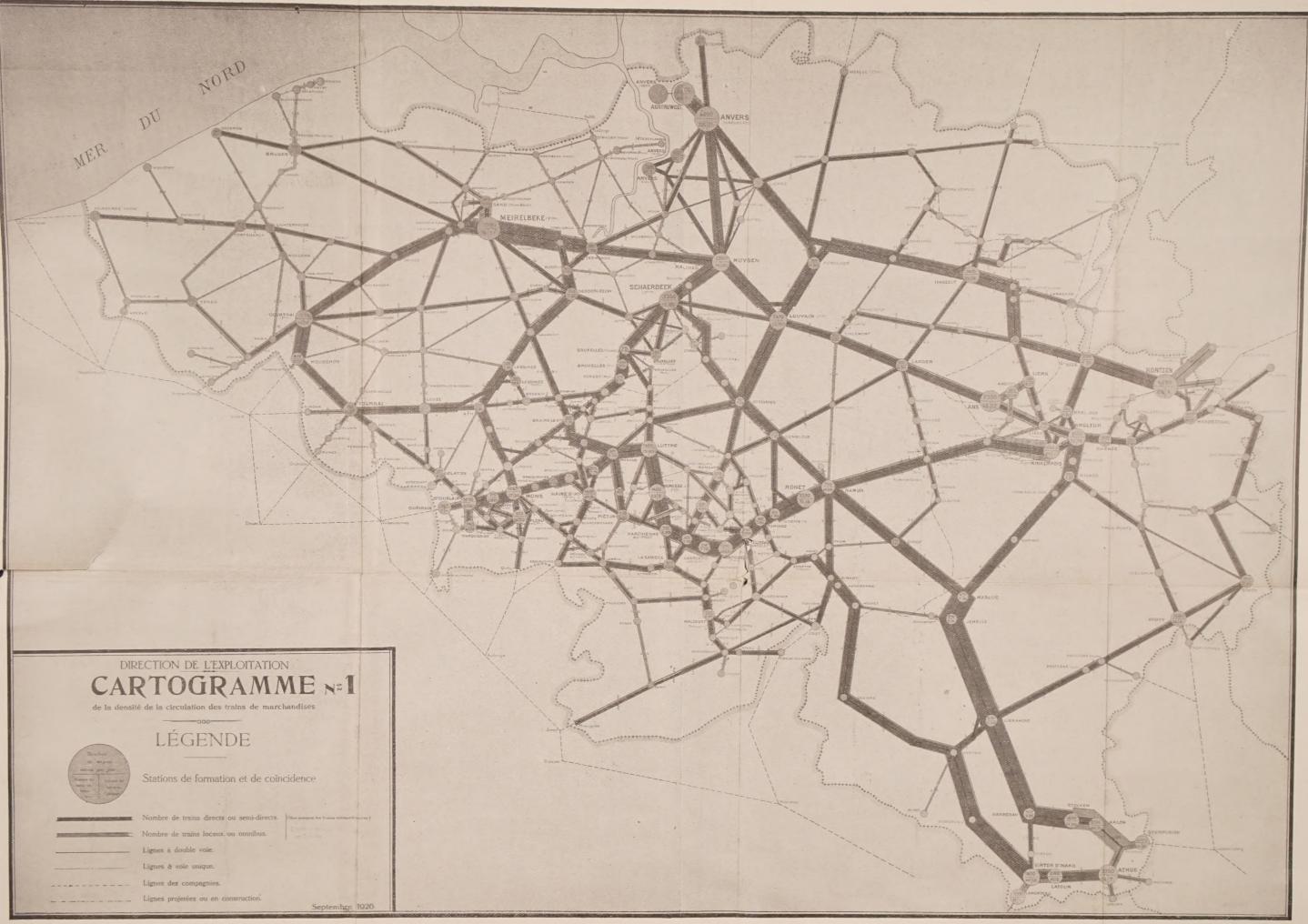


Fig. 1.

Explanation of French terms (left bottom corner): OPERATING DEPARTMENT. DIAGRAM No. 1 of the density of movement of goods trains.

EXPLANATIONS:

In the circle:

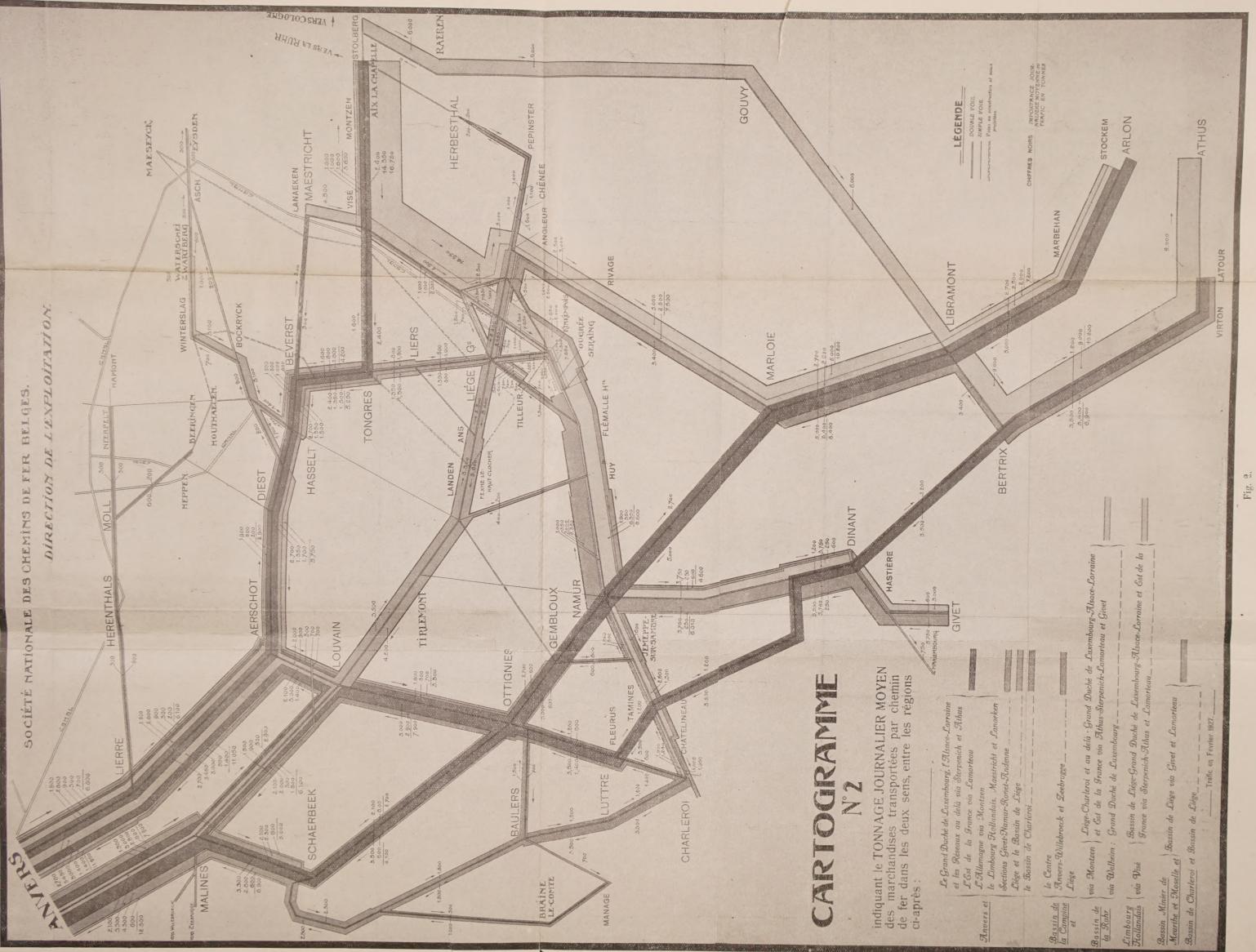
Number of trains entering daily.

Number of trains being marshalled.

Number of trains passing through.

Marshalling yards and converging stations. Number of local or stopping trains.
Double track lines. Single track lines.





"xplanation of French terms
DIAGRAM No. 2
carried by railway in both dire

Cumpine Ant district Libs



540 000 tonnes a year; towards Antwerp 420 000 tonnes; towards Willebroeck and Zeebrugge, 150 000 tonnes, and towards the Centre, 240 000 tonnes;

- 6. Currents from the Ruhr district and from Aix-la-Chapelle via Montzen and via Walheim towards Luxemburg and Eastern France giving 3 300 000 tonnes a year; towards the Liege district and France via Jeumont, 2 805 000 tonnes a year;
- 7. Currents from Limbourg via Visé for Liége, 600 000 tonnes and for France by the Luxemburg line, 750 000 tonnes;
- 8. There are also currents originating in the Charleroi district for the Liége area of 372 000 tonnes. Currents from Meurthe et Moselle via Givet-Namur for Liége giving 1 725 000 tonnes. Currents from the same place and from Luxemburg towards Liége via Latour-Bertrix, giving 1 020 000 tons;
- 9. A current from the Maestricht district towards Antwerp, of 90 000 tonnes a year;
- 10. A current from the Namur district and the line from Namur to Givet towards Antwerp, of 180 000 tonnes.

Currents of the same order exist in the reverse direction.

These are the principal traffic movements noted on the lines in Eastern Belgium, and the volume of traffic is as shewn. The convergence of these traffics gives rise to a very heavy traffic in the neighbourhood of Antwerp. On the two lines from Malines and from Lierre to Antwerp we find a traffic of seven and a half million tonnes per annum towards Antwerp, and in the return direction of four and a half millions.

The whole of the figures that have been given refer solely to the main goods traf-

fic, that is to say, passenger and pick up traffic have been excluded.

What are the capacities of the Belgian railways without building any new lines?

The reply to this question is given in the diagram (fig. 3).

On the original the bands in three distinct colours shew:

- a) The present annual traffic taken from diagram, (fig. 2), but to a scale one quarter that of figure 2;
- b) The increase in the tonnage due to the present pick up traffic, and not shewn on the diagram of figure 2;
- c) The tonnage that could be added to the present traffic by providing additional trains to the extent possible with the single and double lines in use, or on the point of being put into service, and this with the loads being hauled at the present time over these lines.

The fixed plant for handling the goods, etc., should be developed as the traffic grows; it is understood that the stations would receive as necessary the additional machinery found to be required.

We have allowed, based on experience with the Belgian system, that:

— on a single line, 24 trains can be worked daily in each direction; and

— on a double line, three times as many, that is, 72 trains each day in each direction.

These figures are minima. They can be exceeded on short sections on which there are neither water colums nor lay-by lines, such as those near large centres where the number of block sections has been multiplied. They take into account a loss of output of 4 hours out of

the 24 (a sixth) for maintenance and operating difficulties.

These figures have been confirmed by German authors: Doctor Giese, for example, fixes the respective numbers of trains as 24 and 80 for single and double track lines (1).

In addition, Mr. Javary, Director of Operating Services of the French Northern Railway, during the Meeting held in Lille on the 16 January 1921 on the work done by the Northern Railway during and after the War, stated that before the War it was generally agreed to be impracticable to run more than 72 trains in each direction on a double track line thoroughly well equipped for the purpose. Mr. Javary added that on certain days during the War the Northern Company ran 144, thanks to the special character of the military trains and the complete exclusion of any public service.

As regards the tonnage per train (600, 700, 800 and 1 000 net tonnes, according to the lines) it was fixed on the basis of the hauling power at present available.

For goods to be carried in large quantities (coal, iron, ore), for goods from and to foreign railways, for those carried in special wagons, account ought to be taken of the return of the empty wagons to the loading points.

In addition, complete use of the power of the locomotives cannot also be assured (empty wagons, limit of the length of the trains).

In order not to exaggerate in any way, we have therefore considered that the goods trains would only carry in each direction *half* the useful loads given above.

These values are quite normal, and if anything, err by being on the low side.

The following are a few valuable conclusions:

- a) with the present method of operation, the double track Belgian lines can, without interfering with passenger and tranship traffic, carry the following annual tonnages, taking the two directions together:
 - 10 millions on the Ans-Louvain line; 13 millions on the Beeringen-Moll line, and
 - 18 millions on the Moll-Lierre line;
- b) on the lines round about the Campine, the maximum capacity is far from having been reached;
- c) the communications between Antwerp and Liége can be covered by several routes of great capacity.

In short, under the *present* conditions of the system, the transportation capacity of the Belgian Railways can be increased in very large proportions.

3. What will be the capacity for future traffic of the Belgian railways, taking into account the possible operating improvements, the works being carried out, and the new lines projected?

Diagram (fig. 3) shows the *supplementary* tonnage that the railway would be able to carry:

- a) by increasing the useful loading of the goods trains on the most important lines of the regions considered:
 - to 1500 tonnes instead of 1000;to 1000 tonnes instead of 600.
 - 700 or 800;
- b) by doubling certain of the present single track lines;
- c) by allowing for à 20 % increase in capacity of the Stockem to Schaerbeek

⁽⁴⁾ Eisenbahn- oder Wasserstrassenförderung, p. 19. — Publisher of the Verkehrstechnik, Berlin, 1927.

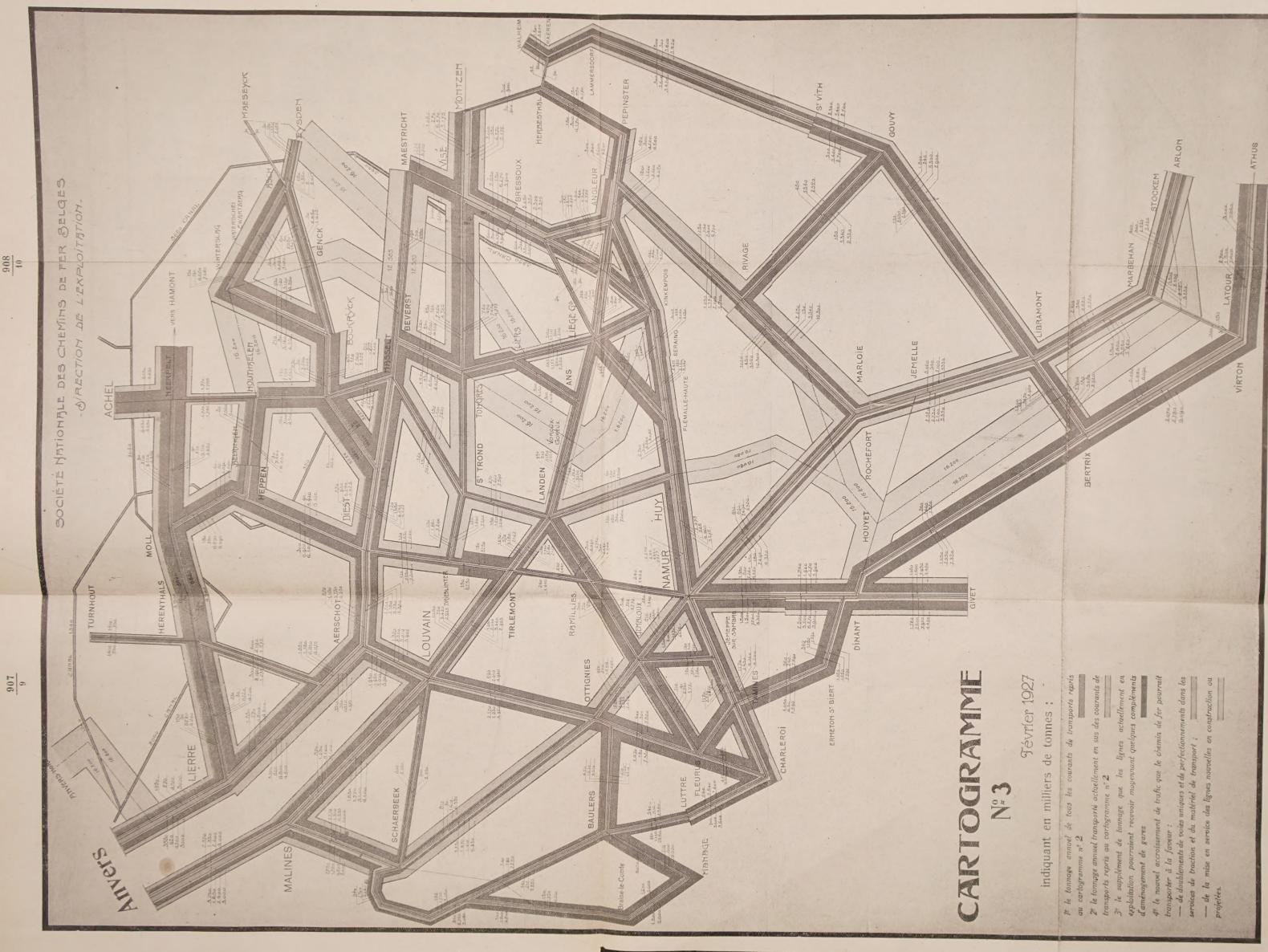


Fig. 3.

LIBRARY OF THE NIVERSITY OF ILLINOIS line, and of the Marloie to Liége line as a result of electrification, and of the fitting of continuous brakes to the goods vehicles;

d) by counting upon the lines the construction of which is in hand, agreed, or under consideration, being available for service.

As regards the operation of the railway, progress can be very rapid. As an example, we have in 1927 increased from 600 to 900 tonnes the useful load of the ore trains over the line from Latour to Bertrix towards the Charleroi district, of the trains carrying manufactured steel from Latour in the direction of Antwerp, as of the trains from Lamorteau towards the Liége district: the load of these last has just recently been further increased from 900 to 1 120 tonnes of useful load.

Trains of 1500 tonnes of useful load are therefore within the bounds of possibility in the near future. The Reichsbahn has put into service wagons of 19 tonnes tare to carry 60 tonnes of goods. Twenty-five such wagons can carry 1500 tonnes of goods, and the gross weight of the train will be 2000 tonnes. Now we have locomotives able to haul this load single headed over the easier lines.

Electrification makes it possible to increase the speeds up gradients: the speed of goods trains can be brought nearer that of stopping passenger trains, and the layby sidings are less used: there are no water columns; and the electric locomotives need be changed less frequently than in the case of steam locomotives.

All these points will undoubtedly result in increasing the output of the lines.

The use of the continuous brake on

goods wagons will lead to the same results.

Taking all these circumstances into account, the traffic capacity revealed by the diagram (fig. 3) can be taken as being the following:

- for the Beeringen Moll Antwerp line, 13 million tonnes per annum in one direction only;
- for the line Genck-Langerloo-Tongres-Fexhe-le-Haut-Clocher - Kinkempois-Bassin de Liége, 12 million tonnes.

It may be recalled here that each of the pits in the Campine coal field is equipped to draw 4 000 to 5 000 tonnes a day, which means 1 200 000 to 1 500 000 tonnes a year. The Genck-Liége line alone would therefore regularly deal with the total production of 8 or 10 pits.

We will therefore conclude that for a very long period the traffic capacity of the Belgian Railways is practically unlimited. The power of the locomotives, the capacity of the wagons, and the number of axles per train can be increased as required.

In neighbouring countries trains are made up of 150 or 160 axles instead of 120. In America wagons of 80 to 120 tonnes capacity are used for bulk traffic.

Three or four tracks can be laid in place of two, etc.

In addition, the National Railway Company has drawn up special rates for the carriage of large quantities which latter help in the formation of heavy and full trains running without re-marshalling from the station of origin to destination, that is to say, at a reduced cost.

PART TWO.

Working costs.

In *industrial* undertakings the *total* cost price of a manufactured product is made up of two parts:

1. The proportion of overhead financial charges (interest, sinking fund, general charges) carried;

2. The production costs which fall on it and which we may call direct charges.

To reduce the total cost price, it is necessary to produce large quantities: the permanent financial charges and the constant part of the general charges weigh less and less on each unit made, and the total cost approaches more nearly the partial cost price given by the direct production charges.

This is the well known effect of the "law of the use of mass quantities".

In railway transport the same thing occurs. To get a low cost so as to be able to reduce the rates, it is essential to be able to count on plenty of traffic and the *traffic in bulk* is that which can be carried at the lowest rates.

We may repeat the three hypotheses we have considered in turn:

1. the present traffic;

additional traffic possible under present conditions;

3. the possible traffic after the lines and equipment have been extended.

We will now consider under each of these hypotheses the effect on the costs.

First hypothesis: Present traffic.

The average cost per tonne-kilometre has been 0.15 fr. for the fourth quarter

of 1926: it is slightly higher for 1927, but here the absolute value of the figures must not be considered, but their relative values.

1. Total cost price.

With a view to the calculation of the average cost price of carrying bulk traffic, we took eight principal currents of traffic of heavy goods, and the cost prices have been calculated in both directions by taking into account the characteristics of existing trains (method of haulage, gross train load allowed, useful load, make-up of the train as regards stock, probable return load). The traffic movements isolated in this way represent 61 % of the total traffic on the lines considered: that is, 13 million tonnes-kilometres daily out of 21 millions.

From table I below, the total expenditure on the 13 million tonne-kilometres of heavy goods carried daily is seen to amount to 1 465 000 francs or 11.15 c. per tonne-kilometre.

This cost price of 11.45 c. only represents 74 % of the average cost price of the system (15 centimes). This fact is explainable by the better utilisation of the stock and the longer haul of the goods trains considered.

This total cost price of 11.15 centimes is made up as follows:

Direct charges 5.30 c.
Indirect charges . . . 3.90 c.
Capital charges . . . 1.95 c.

11.15 c.

The respective proportions of these elements in the cost price of carrying a

TABLE I.

TRAFFIC	Tonne-	Average cost price	Present daily expenditure :							
CURRENTS.	kilometres, per tonne-kilometre, in centimes.		. Total,	Direct charges, in francs.	Indirect charges, in francs.	Capital charges, in francs.				
1	± 125 500	10.25	423 155	200 520	148 454	74 181				
ĮI	217 900	10.66	23 230	11 004	8 150	4 076				
III	1 580 200	8.00	431 050	62 090	46 015	22 945				
IV	1 021 000	11.77	120 160	56 870	42 168	21 122				
V	741 800	9.01	67 580	32 038	23 722	11 820				
VI	4 180 500	13.56	568 980	268 236	199 398	99 346				
VII	487 900	14.00	68 310	35 424	21 958	10 928				
VIII	796 000	8.13	64 710	30 645	-22 685	11 380				
Total	13 150 800	•••	1 465 175	696 827	512 550	255 798				
Cost per tonne	-kilometre :	11.15 c.		5.30 c. +	3.90 c. +	1.95 c.				

TABLE II.

TRAFFIC CURRENTS.	Tonne- kilometres, per day.	Partial average cost price per tonne- kilometre, in centimes.	Total cost, in francs.	Direct, charges, in francs.	Indirect charges, in francs.	Capital charges, in francs.
I	7 103 400	5.95	422 810	314.020	46 060	62 730
II	487 300	6.23	30 250	22 400	3 270	4 580
III	2 003 500	4.88	97 970	74 510	11 190	12 270
IV	1 442 500	6.27	90 450	69 800	10 550	10 100
V	6 464 700	4.54	293 300	222 250	33 220	37 830
VI	5 249 550	5.37	281 740	207 090	31 030	43 620
VII	794 600	5.03	39 970	3 0 990	4 610	4 370
VIII	1 164 500	3.86	44 950	34 470	5240	5 240
Total	24 710 050		1 301 440	975 530	145 170	180 740
Cost per tonn	e-kilometre :	5.26 e.	-	3.94 c. +	0.59 с. +	0.73 c.

tonne-kilometre is therefore 48 %, 35 % and 47 %.

The direct charges include expenditure on fuel, oil, enginemen's wages, maintenance and repair of locomotives and rolling stock.

The indirect charges include the general expenses of administration and supervision, of management, workshops and stations, as well as the cost of maintenance of the track.

The financial or capital charges include the cost of industrial amortization, payments to renewal accounts, etc.

2. Partial cost price or additional cost price per tonne.

This is a question of the cost price obtained by abstracting the costs which continue to be incurred whether the traffic moves or not.

Each time the traffic can be increased without investing new capital for the equipment of the line or the purchase of locomotives or rolling stock, it is quite permissible not to take into account the capital charges already paid by existing traffic, and even to neglect that part of the general charges that will not increase at the same time as the traffic. It may be said in passing, that it is stupid self-deception to call cost prices so calculated « dumping » prices.

If we had to consider the minimum cost per kilometre per additional tonne for the carriage of coal, ore, iron, etc., forming the eight traffic movements considered, the indirect charges and the capital charges would be left out of count. The cost price per tonne-kilometre got out in this way would be only 5.30 centimes (the absolute minimum cost) which is only 35 % of the average cost price of the system (15 centimes).

Second hypothesis: Possible traffic under the present condition of the lines.

1. Total cost price.

The possible increase in the traffic under the « present » condition of the lines may be figured at 31 million tonnekilometres per day over and above the present 21 millions.

The result is that the possible daily total traffic is 52 million tonne-kilometres:

a) Let us first of all calculate the average cost price of this additional tonnage (31 millions) considered separately; let us agree that this traffic will be composed entirely of bulk traffic, of which 24 millions will be distributed over the eight traffic currents previously considered, as shewn in table II.

In order to determine the total cost, we have, as in the previous case, considered some of the trains following these eight principal currents. To each train we have charged:

- 1. The total amount of direct charges attributable thereto:
- 2. Part of the indirect charges, considering the general charges for management, supervision, etc., remain the same;
- 3. The interest and amortization of the new rolling stock required (locomotives and wagons).

The average cost price per tonne-kilometre of *supplementary* traffic is no more than 5.26 centimes, whereas the cost of the present traffic is 41.15 centimes. The first only represents 47 % of the second;

b) Let us calculate the average cost price of the present traffic (24 million tonne-kilometres) increased by the possible traffic considered (34 million-tonne-kilometres) that is to say, of the traffic of 52 million tonne-kilometres.

TABLE III.

	Tonne-kilometres, in millions.	Average cost price, in centimes.	Total expenditure, in millions of francs.
Present traffic	21 × 31 × 52	11.15 = 5.26 = 7.67	2 397 1 635 4 032

TABLE IV.

_	Tonne-kilometres, in millions.	Direct charges per tonne-kilometre, in centimes.	Total direct charges, in millions of francs.
Present traffic	21 ×	5.30 =	1 139
	31 ×	3.94 =	1 225
	52	4.49	2 364

The total cost is 4 032 millions for 52 million tonne-kilometres, whence a cost price of 7.67 centimes.

The average cost price per tonne-kilometre would therefore fall from 11.15 to 7.67 centimes, that is to say, it would only represent 51 % of the average cost-price on the system (15 centimes) thanks to a full use of existing equipment.

2. Partial cost price (present plus supplementary traffic). If in certain particular instances we were led to consider the minimum minimorum kilometric cost of the supplementary tonnage, we should only take into account the direct charges in calculating the total cost.

Under the second hypothesis the minimum minimorum cost price falls to 4.49 centimes per tonne-kilometre, as compar-

ed with 5.30 centimes in the first hypothesis, it being understood that in this second hypothesis we have taken the whole of this traffic of 52 million tonnekilometres as being made up of bulk traffic.

Third hypothesis: Possible traffic in the event of the lines and equipment being increased.

Total cost price.

The additional number of tonne-kilometres that could be worked after strengthening up the available equipment amounts to 26 million tonne-kilometres per day (that is, over and above the 52 millions).

In the absence of any indication as re-

gards the kind of trains to be hauled, the composition of the trains, and the dates the new capital would be available, it is impossible to establish an absolutely precise cost price under the third hypothesis.

Let us agree it will not be higher than that of the additional traffic of the second hypothesis (or 5.26 centimes) increased by the rate corresponding to the new capital charges. The number of tonne-ki-

lometres to take into account is 52 + 26= 78 million tonne-kilometres per day.

Let us estimate the interest and amortization charges at 10 % of the new capital, the increase per tonne-kilometre is 0.65 centimes and the average total cost price rises to 5.26 + 0.65 = 3.91 centimes in place of 11.15 centimes, representing therefore only 40 % of the average cost price of the whole system (15 centimes).

THIRD PART.

Rates.

The cost prices control the rates in the sense that they fix the minimum limit.

In order to determine the costs of carriage the railway ought to or should charge in the future, let us again consider our hypotheses.

First hypothesis. — Present position, therefore present rates.

Second hypothesis.—It has been shewn that in their present state the lines considered can deal with a supplementary daily traffic of the order of 34 million tonne-kilometres per day.

If this additional traffic was considered separately, it could be carried at the price of 5.26 centimes without the rate falling below the cost price. But the reduction of rate should apply not only to the supplementary traffic but also to the traffic being handled.

Let us consider then the total traffic under the hypothesis that the lines considered are being operated to saturation point, that is to say, if the volume of the traffic was 21 + 31 = 52 million tonne-kilometres per day: under these conditions the actual traffic of 21 million tonne-kilometres would be carried at the

price of 7.67 instead of 11.13 centimes.

There would result a saving of 11.15 — 7.67 = 3.48 centimes per tonne-kilometre, or an annual saving of the order of 220 million francs (1) which would allow a general reduction of 11 % on the whole of the rates.

Third hypothesis. — Reductions of rates the railway could grant if we allow for an increase in the capacity of the lines obtained by extending the lines and equipment.

The works in view under the third hypothesis would require an immobilisation of capital, the amortization and interest on which would amount to 0.65 centimes per tonne-kilometre, but would enable 78 million tonne-kilometres to be carried, whence a reduction of 11.15—5.91—5.24 centimes in the cost price per tonne-kilometre. This reduction would enable the railway to effect an economy of the order of 330 million francs corresponding to a general reduction of 16 % on the whole of the rates.

⁽i) 3.48 centimes × 21 millions of tonnes-kilometres × 300 days.

As can be seen, if we have bulk traffic, the railway can without « dumping », rates that is to say, without carrying

goods at rates below the cost price, offer very low rates equal to if not lower than those of other methods of transportation.

CONCLUSIONS.

If we regard it from the point of view of the traffic, the capacity of the Belgian railways is practically unlimited. The line from Beeringen to Antwerp alone can carry annually towards Antwerp, that is to say, in a single direction, 13 million tonnes, i. e., half the coal mined in Belgium. This is indeed reassuring for the railway future in the Campine. If we consider it from the point of view of the cost price of carriage, and from that of the rates, we can conclude that each time that for any reason any traffic is taken from the railway, the cost price of the railway will automatically rise, and result in an appreciable increase in rates.

In order to have very low rates, it is

necessary to concentrate on to the railway as much traffic as possible. Thanks to carriage of traffic in bulk, the railways will be able to use high capacity wagons, thereby reducing the operating costs, making better use of this capacity and getting a quicker turn-round of the stock.

The greater the volume of traffic, the easier it is to form an economical organisation, and the easier to group the elements of the traffic into currents which enable complete train loads, running at high speed, to be worked from the point of origin to the destination without check, in other words, trains which will give the minimum cost price.

Central white stains in ingots rolled before complete solidification,

By Mr. VITEAUX.

Figs. 1 to 10, pp. 917 to 920.

(Le Génie Civil.)

In an article recently published in the Génie Civil (1), Mr. Pichard developed certain arguments on the phenomena accompanying the solidification of steel ingots, and in particular on the formation of the « white stain » in ingots that have been rolled before the steel had completely solidified. He considered that during cooling, a central zone D (fig. 1) of the ingot which would have practically the same composition as the original metal or would be slightly freer from impurities as a result of liquation, remained in surfusion: too early rolling would fix the whole of the metal in zone D accompanied by a separation of impurities from D towards the surrounding zone C.

This explanation is very different from the theories so far brought forward to explain the formation of the « white stain » and does not agree with the very definite results of experiments we carried out some months ago, to see if these theories were well founded: we think the question ought to be completely elucidated.

Mr. Pichard appears to have based his theory principally on the macrographic appearance of rails having this « white stain », without having taken into account sufficiently, the very special chemical composition of these rails. Now rails with the « white stain », or more generally the products obtained by premature rolling of the steel ingots (in steel works language, young ingots) show in addition to the « white stain » characteristic of their macrographic appearance, a very definite heterogeneous chemical composition: this heterogeneity shows itself not only by the content of impurities, such as sulphur and phosphorus, but, and this is a point of capital importance, by the content of carbon.

The macrograph (fig. 2) is a picture of the section of a bloom of 170×180 mm. (6 $11/16 \times 7$ 1/16 inches) intentionally rolled from a steel ingot before complete solidification: at the points marked A, B, C, etc. on the photograph, we took, using a 7 mm. (9/32 inch) drill, samples for analysis. The following table gives the results obtained.

Content		Samples.												
per cent of	A	В	С	D	Е	F	G	н	I	J	x	Y		
Mn	1.000	1.055	1.010	1.005	0.975	0.955	0.925	0.890	0.910	0.910	1.000	2.000		
	0.075							0.026		0.023	0 .068 0.0 3 9			

⁽¹⁾ See the Génie Civil of the 11 February 1928, vol. XCII. No. 6, page 132 and the Bulletin of the International Railway Congress, September 1928, page 751.

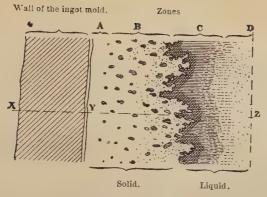


Fig. 1. — Part section of an ingot during solidification.

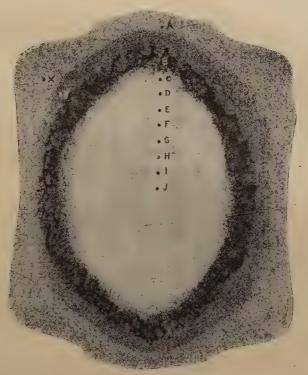
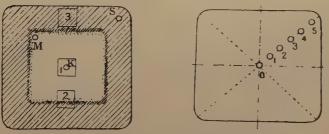


Fig. 2. — Bloom made from a rail steel ingot rolled before complete solidification.



Figs. 3 and 4. - Steel ingots tested by Mr. Karl Neu.

It will be seen that the metal in the white central area, and particularly that in the area H-I-J, completely differs in chemical composition from the steel as originally poured, and it would seem very difficult to admit that liquation only, followed by a phenomen of surfusion, necessarily followed in turn by sudden solidification, could produce the considerable impoverishment in *carbon* phosphorus and sulphur, that an analysis reveals.

Mr. Karl Neu when director of the Neunkirchen Rolling Mills, appears to have been the first to point out the existence in ingots rolled before complete solidification of a central zone weaker in carbon, phosphorus and sulphur than the surrounding parts.

In Stahl und Eisen of the 7 March 1927, Mr. Neu gave particulars of many tests from mild steel and rail steel ingots: it will be sufficient if two sets of test results be quoted:

1. Analyses and mechanical characteristics of a mild steel ingot weighing 2 800 kgr. (6 170 lb.) rolled into 80×80 mm. (3 5/32 \times 3 5/32 inches) billets after half an hour in the scaking pits (fig. 3).

Tests marked	СР	Mn	S	Tests.	Breaking strength.	Raduction of area.	Elongation on 100 mm. (3 f5/16 inches).
S	Per cent. Per cent.	Per cent. 0.42 0.46 0.39	0.050	1	Kgr. per mm ² (lb. per square inch). 34.5 (49 070) 41.7 (59 300) 35.4 (50 350	Per cent. 60.8 26.3 61.6	Per cent. 36 28 38

2. Analyses from a rail steel ingot (2 tons) rolled into blooms after 15 minutes in the soaking pits $(fig.\ 4)$.

Tests.	G	P P	Mn	S
	Per cent.	Per cent.	Per cent.	Per cent.
0	0.09	- 0.035	0.96	0.027
1	0.16	0.030	0.88	0.020
2	0.26	0.035	0.98	0.041
3	. 0.38	0.075	1.06	0.127
4	0.34	0.065	0.98	0.085
5	0.36	0.040	1.00	0.081

At the end of the article Mr. Neu endeavoured to explain the phenomenon by the compression action of the blooming mill rolls causing the liquid core to penetrate into the surrounding zones already solid, but still offering little resistance « in the way mercury penetrates a leather bag ». A point however re-

mained without explanation « that is, the fact that in every case the core itself of the ingot always showed a reduced carbon content. However surprising and enigmatic this may be at the moment, it is however, an incontestable fact ».

It fell to Mr. E. Houbaer, Engineer of Messrs. Cockerill, to provide a logical

and complete explanation of this phenomenon. At the 1913 meeting of the « Iron and Steel Institute », Mr. B. Talbot proposed a method of producing sound steel by lateral compression. The process consisted in a slight drawing down of the ingot at the blooming mill before complete solidification in order to prevent piping. Mr. E. Houbaer investigated at Messrs.Cockerill's works at Liége, the possibilities of applying industrially the Talbot process, and reported the results of his tests in the Revue universelle des Mines et de la Métallurgie (March 1913). He pointed out the existence of the « white stain » in steel manufactured by the Talbot process: he referred to Mr. Neu's tests, and finally explained the phenomenon by linking it up with the well known laws governing the solidification of binary alloys. The theory of Mr. Houbaer may be summed up as follows.

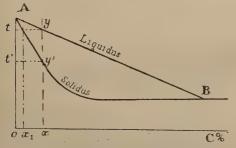


Fig. 5. — Diagram of a binary alloy.

Let us take (fig. 5) a steel of x carbon content when liquid: when during cooling down the steel falls to the temperature t, in the binary system Fe-C there will form crystals having a carbon content x_1 , lower than x: at the same time the carbon content of the mother liquor will increase; the temperature continuing to fall, the quantity of crystals will steadily grow and their carbon content will gradually approach more nearly to x; the carbon content of the liquor will also increase in measure as the mass of the free liquid diminishes.

If we consider the binary system Fe-Ph analogous to the system Fe-C (1), it will also be seen that there will separate out from the liquid mass, after a certain temperature, crystals poorer in phosphorus than the mother liquor, etc. In the case of the sulphur which forms as a rule complex sulphates insoluble in the liquid steel, the position is different: certain globules of sulphates will be held by the crystals, but the major part will accumulate in the liquid.

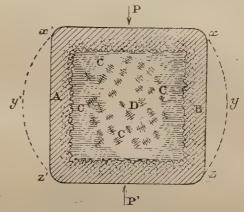
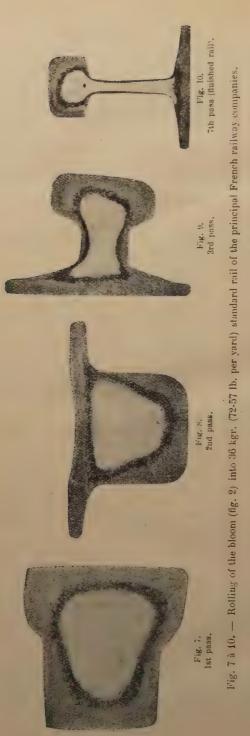


Fig. 6. — Cross section of an ingot during solidification.

Finally, an ingot in course of solidification can be likened to a box, the sides of which would be the parts that first solidified against the ingot mold. If we suppose the ingot to be laid down horizontally and we take a vertical section (fig. 6) through the middle of its length, this section will show a solid casing A, the interior of which consists of an open agglomeration of crystals intersected by intersticial spaces more or less full of pasty material B in process of solidifying, and at the centre a mass D of crystals

⁽¹⁾ See the paper published by the sub-committee of the Iron and Steel Institute: On the homogeneity of steel ingots, in the Proceedings of the Iron and Steel Institute, May 1926,



tals of low carbon, phosphorus and sulphur content plonged like a sponge into a liquid C rich on the contrary in these elements. The difference in composition between the crystals and the mother liquor will be furthermore the greater, as the temperature is higher, the purest crystals consequently being found at the centre of the box.

Let us now suppose the ingot be rolled down, the ingot being sufficiently set at the head and base for the steel, still liquid, not to run out at the ends. Under pressures at P and P', the non malleable liquid or pasty mass C endeavours to escape in the perpendicular direction, that is to say laterally and enlarges the ingot at x, y, z, x', y', z': it separates from the « sponge » like mass of crystals D as by a real squeezing, and collects between the solid walls A and the solid core D penetrating more or less deeply as Mr. Neu indicated, the rather open grained dendritic zone B, which primitively surrounded the zone A about C.

The result of this is the formation on the one hand, of the central white stain, and on the other, of the ring of impurities shown in the macrograph (fig. 2).

The phenomena are in reality more complex than those we have described. We are not dealing with isolated binary systems, but with a complex Fe-C-Ph-Mn-Si system; furthermore, the temperature continues to fall and solidification proceeds as the rolling is carried on; finally diffusion comes into action to a certain extent. A more complete description of these phenomena will be found in Mr. Houbaer's original note; this resumé however, should be sufficient to give an idea of the effects produced.

If the solidified case A is not sufficiently thick when the ingot begins to swell out, this case breaks, either at various separate points, or even the full length of the generatrices y and y', sometimes accompanied by the liquid being driven out with great violence. It is

consequently advisable to observe considerable prudence when carrying out these tests.

As we have said above, we were led, during the past year, to investigate the formation of « white stain » in rails: we repeated the tests made by Messrs. Neu and Houbaer: we obtained results agreeing in every respect with theirs, and we believe that the theory put forward by Mr. Houbaer, explains in a very satisfactory manner the succession of the phenomena.

These tests of rolling « young » ingots have a direct value for metallurgists, as they make it possible to lay down with exactitude the conditions to be followed to avoid the formation of the « white stain ». From a more general point of view, they are also of very great value, because they make it possible in some degree, to stabilise and to seize upon as they occur certain transition phases of the solidification of steel ingots.

An illustration, such as figure 2 for example, completed by analysis from different points of the « white stain » shows the importance under certain conditions of cooling, delay in the diffusion in the crystals first formed, can assume.

When compared with the observations made by the Sub-Committee of the Iron and Steel Institute which enquired into the homogeneity of steel ingots, it makes it possible to understand more easily certain anomalies and certain heterogeneities pointed out by this Committee and

which are experienced more particularly in the case of large ingots for forging (1).

The rolling of blooms showing the white stain, can, in addition, give valuable information on the work done during rolling (or forging), and about the deformation the metal undergoes at different parts of the section, during succeeding passes through the rolls, etc.

As an example, we give a series of macrographs (figs. 7 to 10) taken from test pieces and from the same bloom during rolling into a French Railway standard 36-kgr. (72.57 lb. per yard) rail. This bloom is the one of which we have already given a macrograph (fig. 2) and which was made from an ingot rolled deliberately before complete solidification.

If we compare the macrograph of the initial bloom with that from the finished rail (fig. 10) we may be astonished a priori, that the internal ring of impurities which on the bloom is some distance from the surface, should, in the finished rail, be level with it at certain points, and in particular at the radii between the web and the foot: the macrograph taken after the second pass (fig. 8) at once explains this abnormality. Observations of this kind will, in certain cases, result in the grooves in the rolls in the rolling mills, being cut to a more scientific design.

⁽¹⁾ See the article cited above.

Proposed turbine locomotive design.

Figs. 1 to 3, p. 923 and 927.

(Railroay Mechanical Engineer.)

The International Railway Fuel Association held its 20th annual convention on the 8 to 11 May inclusive in Chicago.

Twelve papers by individuals and thirteen reports of committees were read before it.

Amongst these latter was one dealing with the turbine locomotive and containing a detailed description of a proposed turbo-electric locomotive.

The committee responsible for this proposal was composed of men from the railways and also from the locomotive builders. It considered the various trial locomotives that have been built in Europe as well as other designs suggested by Messrs. Ljungström, of from 4 000 to 8 000 H. P. corresponding to a drawbar pull of 78 000 to 191 000 lb. and having a total weight of 830 000 lb. for the higher power.

As a result of its investigation into earlier schemes and of its enquiries into recent practice, the committee put forward the turbine locomotive the particulars of which given below have been taken from the Railway Mechanical Engineer.

* *

Proposed turbine locomotive design.

The committee, after carefully checking the progress made in Europe, believes that this type of locomotive deserves serious consideration. A locomotive of this type should have many advantages over the present type. We believe that the best method of bringing the turbine

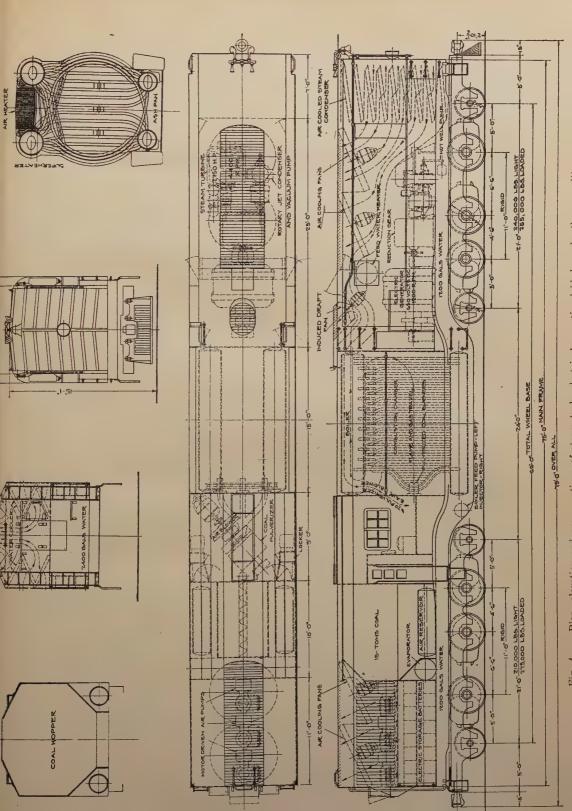
locomotive to the attention of this association is to make definite recommendations covering a specific design.

This has been done, and we submit herewith a design for a 2500 H. P. steam turbine locomotive suitable for either heavy passenger or fast freight service, the starting tractive force of this locomotive to be 100000 lb. and the maximum speed 65 miles per hour.

The power for this locomotive is obtained from a steam turbo-electric generating unit furnishing electric current to motors geared to the driving axles. The steam turbine drives the electric generator through a set of single-reduction gearing.

Steam at 400 lb. pressure and 700° F. maximum temperature, at the turbine throttle, is furnished by a water-tube boiler of compact design. The exhaust steam from the turbine is condensed by a closed feed water heater, an air-cooled condenser at the front of the locomotive and a combined rotary jet condenser and vacuum pump, having the jet cooling water cooled by an air-cooled radiator at the rear end of the locomotive.

The general construction of this locomotive consists of a main frame of cast steel 75 feet long carried on two 10-wheel trucks, each truck to have three pairs of driving and two pairs of guiding wheels, one pair at each end. The greater portion of the main frame is to have a sheet steel housing on top of it, the cross section to come within the road clearance limits.



Plan, elevation and cross sections of steam turbo-electric locomotive laid down by the committee. Fig. 1.

The general arrangement of the parts of the locomotive, beginning at the front end, is the air-cooled steam condenser and cooling fans, steam turbine, rotary jet condenser and vacuum pump, electric generator, steam boiler, cab containing coal pulverizer and all locomotive controlling apparatus, coal bunker, water tank, water cooling radiator and cooling fans, an electric storage battery to start and operate the motor-driven auxiliaries, and to furnish electric current for the headlight and cab lighting, and an evaporator to evaporate all the raw water from the storage tanks, and pass it on as steam to the condenser. This will insure clean, pure feed water for the boiler.

Transmission.

A single-unit type construction is to be used instead of the usual double-unit arrangement of engine and tender. This makes possible a well-car type design at the center of the main frame between the trucks and permits the use of a very compact design of water-tube boiler with comparatively large combustion chamber.

The unit type construction eliminates the use of the usual drawbars, chafing plates and buffers, and hose or flexible metallic connections for water, air and steam which would be required if a two unit arrangement was used. A satisfactory design has been worked out for the main frame which has to be cast steel in one piece. Each truck frame is also to be cast steel of one-piece construction.

Electric transmission is to be used to permit the most flexible arrangement and the location of the driving wheels at both ends of the locomotive. This provides maximum weight on driving wheels and maximum tractive force at starting. Roller bearings are to be used on all driving and truck axle journals.

Steam boiler.

The steam boiler will be of the watertube type, of compact design. It will

carry a maximum steam pressure of 450 lb. and have a superheater to give a maximum steam temperature of about 700° F. The design of the boiler is such as to provide rapid circulation of the water in it, which will insure maximum evaporation from the heating surface the greater portion of which is in the firebox. The weight of this boiler and the amount of water carried in it will be about one-third of the weight and water capacity of a standard locomotive boiler. At the back of the firing end of the boiler an ignition pocket is provided so that powdered coal or oil can be used for fuel.

Steam ash and soot blowers are to be provided for removing the ash and soot from the tubes in the boiler, an ash pan being located under the boiler firebox. The ashes are to be removed from this ash pan by means of a steam ash blower through a door provided at the front of the pan.

An air heater is to be used for heating the air for combustion to a high temperature before it is blown into the combustion chamber. The air is heated by the waste gases from the firebox after they have passed through the superheater. The flow of the air through the heater will be counter-flow to the flow of the waste gases, which will provide highest air temperature and highest efficiency.

A 10-H. P. motor-driven exhaust fan will be used to provide induced draft through the combustion chamber, superheater and air heater and to discharge the gases from the top of the locomotive.

The fuel will be powdered coal. A 50-H. P. motor-driven unit pulverizer with a capacity of 5 000 lb. per hour will be located in the cab between the boiler and the coal hopper which has a capacity of about 15 tons. The coal from the storage hopper will be conveyed to the pulverizer by a screw conveyor similar to that now used on stoker-fired locomo-

tives. The amount of coal and heated air entering the pulverizer can be regulated to suit requirements. All air for combustion is heated to a high temperature. About 25 % of this air will pass through the pulverizer for conveying, drying and heating the pulverized coal. About 25 % of the air will be blown into the coal and air pipe before it enters the burners. The remaining 50 % of air will be blown into the combustion chamber, as secondary air, at several points around the ignition pocket.

Pulverized coal burners.

Three flat-flame pulverized-coal burners are to be used, one in the center and one on each side of the ignition pocket of the combustion chamber in the boiler. The construction of these burners is similar to a gaslight burner to give a turbulent, thorough mixing of the air and pulverized coal.

The burners will give a short, intensely hot flame which will ignite close to the burner. The three burners will provide a wide range of capacity. The center burner is to be used when starting the fire or for maintaining heat for holding steam pressure. The two outside burners are to be used when the locomotive is working at low or medium capacity. All three burners are to be used when the locomotive is worked to maximum capacity. Each burner is to have a capacity range of over 50 %. It will not be necessary to dry or crush the coal before placing it on the locomotive any more than would be required for a stoker-fired locomotive.

The turbine and generator.

The steam turbine will be designed to meet the shocks and additional stresses of operating in a locomotive. This will require some modification of standard engineering practice now used in laying out this type of equipment for stationary power plants. The turbine will, however, be based as nearly as possible on a unit of approximately 4 400 revolutions per minute, combining the best practice available. The maximum efficiency of the turbine will be selected to give minimum steam consumption at full load in order to favor the condenser operation. Steam consumption will be about 9 lb. per horse-power-hour at 26 inches vacuum, and at full speed.

The turbine will be geared to a generator operating at 1 200 revolutions per minute or higher. The ideal speed cannot be determined until the design is actually laid down. The generator will be a d. c. machine with a field so arranged that the main voltage may be modified over a range from 650 down to a safe value for the motors under starting conditions. There will be an exciter on the shaft of the main generator to furnish current for the control, compressor, battery charging and auxiliaries.

The motors will be arranged for seriesparallel connection in order to secure maximum efficiency and the best operating combination for the main generator and the traction motors. The traction motors will be of approximately 400 H. P. rating each. The characteristics of the series motor are ideal for traction purposes in ensuring an even torque up to the slipping point of the wheels. The motors will absorb the full output of the generator at any speed of the locomotive.

Condensers.

The condensing problem presented by this locomotive shows that it will be called upon to condense 30 000 lb. of steam per hour at a 26-inch vacuum under maximum operating conditions. The design will be such that 1/6 of this amount of steam will be bled from the turbine for the purpose of heating the feed water; 3/6 of the steam will be con-

densed in the main air-cooled condensers; 2/6 will be condensed in the rotary jet condenser and vacuum pump.

The condensing system will be divided into two parts: the actual steam condensers, which will operate at the front of the locomotive and will be required to condense 15 000 lb. of steam per hour, and the watercooling condensers or radiators which will be required to dissipate heat equivalent to 10 000 lb. of steam at a 26-inch vacuum and which will function at the rear of the locomotive as a supplement to the rotary jet condenser and vacuum pump.

At the front end we have arranged to incorporate approximately 280 square feet gross frontal area of copper condensers. These condensers will be built along the same principle as an automobile radiator, being a multiplicity of flattened tubes over which fins are placed and bonded by various methods. The condensers will be built entirely of copper, using seamless tubing, which in turn will be brazed into ingot-iron or copper head sheets and distributor tanks. The actual condensers will be built in sections approximately 12 inches in width by 48 inches in length. These sections will be attached by unions to a central header and return lines. section can readily be removed for servicing or cleaning and replaced by merely removing two or three nuts. entire system will be protected by a fine mesh screen (5 or 6 mesh) to overcome any tendency toward clogging due to bugs, grasshoppers and other foreign matter which may be carried in with the cooling air.

Each set of condensers will be supplemented by two propeller-type fans using the same principles as are embodied in aeroplane propellers. Each fan will require 25 H. P. for operation and will move approximately 150 000 cubic feet of air per minute. The fans are to be arranged so that all air discharges upward,

inasmuch as air will be discharged from the condensers at points over the fan with a velocity as high as 3 000 feet per minute. This would be objectionable for either downward or sidewise discharge when passing stations.

A hot-well pump will be required to return the condensation from the air-cooled steam condenser to the boiler feed pump.

The rear cooling system will act supplementary to the rotary jet condenser and vacuum pump. This cooler will be required to do somewhat more work than the other end, inasmuch as on the front end you will be dealing with steam at approximately 126° temperature, while the cooler must handle water as low as 10° above atmospheric temperatures. For this reason the same fan equipment will be required for the rear end cooler even though there are actually less heat units to be dissipated. The rotary jet condenser and vacuum pump and the hotwell pump will be driven from the turbine shaft. The rotary jet condenser will have a booster pump on the same shaft to return the circulating water to cooling system at the rear end of the locomotive. After being cooled, the water returns to a storage tank under the cooler and is again pumped through the rotary jet condenser and vacuum pump.

A closed-type feed water heater will receive steam at 60 lb. pressure, bled from the steam turbine. This heater will raise the temperature of the feed water to about 317° F. before entering boiler. A steam-jet heater will be used to heat the boiler feed water before it enters the boiler feed pump which is of the centrifugal type, turbine driven. iet heater is to receive the exhaust steam from this steam turbine, the condensation from the closed type heater and the water from the hot-well pump, to mix with water discharged from the booster pump connected to the rotary jet condenser.

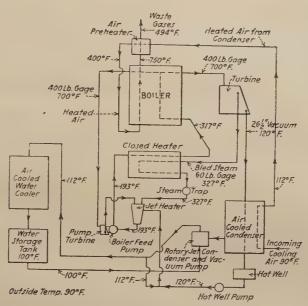


Fig. 2. — Heat flow diagram of the proposed turbo-electric locomotive.

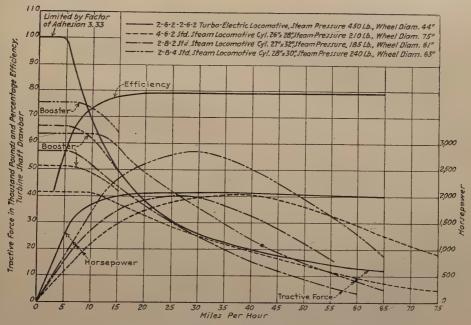


Fig. 3. — Drawbar horsepower — tractive force — efficiency-speed curves.

Feed water heater, pump and injector.

The maximum temperature of the feed water before entering the boiler feed pump will be 193° F. The pump will discharge the feed water through the closed type heater where it will be heated to about 317° F. as stated above. A hot water injector will be used to supplement the boiler feed pump and will receive water from the line supplying water to the rotary jet condenser and vacuum pump.

A steam-heated evaporator, receiving steam bled from the steam turbine, will be used to evaporate all water passing from the storage tank to the rotary jet condenser cooling water storage tank. The water evaporated in the evaporator will be drawn as steam into the rotary jet condenser and condensed and returned to the cooling circulating system or to the boiler as feed water.

The evaporator is located between the coal and water storage and provides a positive means of purifying the water to be used in the boiler. No water treatment of any kind will be required for the water entering the evaporator. The amount of make-up for boiler feed would be comparatively small except when the locomotive is used for hauling passenger trains and steam is required for heating.

An electric storage battery of about 150 cells and about 90 kilowatt-hours capacity will be used and located at the sides of the water storage tank at the rear end of the locomotive. This storage battery is of sufficient capacity to operate the coal-pulverizer motor, induced-draft-fan motor, air-pump motor and lighting system for about two hours. This will provide a convenient means of operating these auxiliaries independently of the main turbo-generating set or any outside source.

A heat-flow diagram has been made to show the heat flow and also the cycle of operation for the water, steam and air used in the power generating plant. This diagram may at first appear complicated, but the cycle and the operation of the apparatus on the locomotive is very simple and requires the least possible attention.

Heat balance.

The heat balance has been calculated respectively for the standard steam locomotive and the turbo-electric locomotive. The figures are shown in the table below.

Heat balance of a standard steam locomotive.

Loss to sparks		4	%
Loss to gases		18	%
Loss to ashpan		4	%
Loss to radiation		4	%
Loss to air and boiler pumps.		. 6	%
Loss to exhaust		55	%
Loss to friction		1	%
Total losses.		92	%

Returned by feed water heater. . 10 % Useful work 8 %

Heat balance of a steam turbo-electric locomotive.

Loss to sparks	2	%
Loss to gases	12	%
Loss to ash pan	2	%
Loss to radiation	3	%
Loss to auxiliaries	4	%
Rejected by condensers	52	%
Loss to generators, motors and		
gear reduction	7	%
Loss to friction	1	%

			Total	losses.	٠	83	%	
Returned	by	feed	water	r heate	r.i	14.5	%	

Returned by	use of condenser	2 2 2 0 70
heated air		0.5 %
Returned by	air heater	7.5 %
Heaful wonle	the state of the s	47 0 M

The percentage of useful work obtainable from the coal for the standard steam

locomotive, is 8 % as compared with 17 % for the turbo-electric locomotive. This indicates that the turbo-electric locomotive will use less than half the coal used by the standard steam locomotive when doing the same amount of work.

The turbo-electric locomotive should also use very much less coal during stand-by time than the standard steam locomotive, on account of the use of pulverized coal for fuel.

Horsepower, tractive force and efficiency-speed curves have been made up to cover the comparison of the turbo-electric locomotives with several standard steam locomotives of about the same or greater horsepower capacity. These curves clearly indicate that the turbo-electric locomotive has greater tractive force at all speeds than the standard steam locomotive of practically the same horsepower, and also that it has considerably greater tractive force at low speed and also at high speed, than a standard steam locomotive having considerably greater horsepower.

The turbo-electric locomotive has a high tractive force at low speeds, as shown on the diagram, which gives it a distinct advantage over the standard steam locomotive. In other words, the turbo-electric locomotive is able to produce a greater tractive force than the standard locomotive at any speed, due to

its being able to work its power plant at practically full capacity under all conditions. It can, therefore, handle greater tonnage under all conditions. This makes the turbo-electric locomotive practically on a par with the electric locomotive, within the limits of its power plant capacity.

The turbo-electric locomotive can operate where any standard steam locomotive can be used and can also be designed to operate over electrified zones with electric current received from an overhead wire or third rail.

The turbo-electric locomotive should have many advantages over the standard steam locomotive, particularly when equipped to burn pulverized coal, which should make operation practically as flexible as when oil is used for fuel. The standby-losses, with powdered coal should be very low and the time required for cleaning ash pans reduced to a minimum. The operation should also be practically smokeless.

The use of boiler feed water evaporated and purified on the locomotive should reduce the cost of water to a minimum. It should also reduce the labor and maintenance cost for the locomotive boiler and keep it clean and efficient at all times, and practically eliminate the necessity for boiler washing.

Statistics of rail breakages during the year 1927.

In accordance with the resolution passed at the London Congress, 1925 (1), we publish below the information which has been sent in by the adherent administrations on the subject of the breakages of rails which occurred on their systems during the year 1927.

⁽¹⁾ See Bulletin of the Railway Congress, March 1926, p. 240.

	proof als	x o mu mixoU	-	English tons.	2 to 18				-	sh				_
	11 :	or per 625 miles.		tor	12 to	19			17	English	18.4	18.4	:	
	20 years.	Number of fractures per 1 000 km,	91		36.22	1.81	15 84	n-kilometı	16		5,597	:	5.597	kilometre
	More than	Length of single track of this class,	15	Miles.	1 189.7	1 719.9	2 909.6	0 000 train	15	Miles.	1 665	:	1 665	000 train- 36.
	Σ	Number of fractures.	14		69	īυ	74	10 00 es : 6	1+		15	:	15	33.8
	years.	Mumber of fractures per 1 000 km. or per 625 miles.	13		3.67	1.45	2.35	ures per train-mil	22		2,239	3,306	2 435	res per 10 ain-miles
	15 to 20 years.	Length of single track of this class.	12	Miles.	1 189.7	1 719.9	2 909.6	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 6.26,	12	Miles.	1 665	376	2 041	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles; 33,836,
		Yumber of fractures.	=_		7-	4	=	umbe	Ξ		9	82	00	mber or 6
rails:	/ears.	Mumber of fractures per 1 000 km. or per 625 miles.	01		0.53	1.45	1.07	Z	10		0.373	1.653	0.609	Nu
Age of rails	10 to 15 years.	Length of single track of this class.	6	MILES.	1 189.7	1 719.9	2 909.6		6	Miles.	1 665	376	2 041	
		Number of fractures.	20			4	73						62	
	10 years,	Number of fractures per I 000 km, or per 625 miles.	i-		ф ф	0.36	0.36		7		0.373	1.653	609 0	
	5 to 10 y	Length of single track of this class.	948300		:	1 719.9	1 719.9	<u>.</u>	9	Miles.	1 665	376	2 011	
		Number of fractures.	ت م	2 t	:	7			5		-	_	2	
	years.	Number of fractures per 1 000 km, or per 625 miles,	4		0.53	:	0.53		4.		:	6.612	6.612	
	Less than 5	Length of single track of this class.	3 Wiles	_	1 189.7	:	1 189.7	.017	ca .	Miles.	:	376	376	జ్ఞ
	Le	Mumber of fractures.	ા		-	:		180	83		:	4	4	693 0
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	ARGENTINE.	Buenos-Ayres and Pacific Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total	Number of train-miles: 9 180 710, Total number of fractures: 92.		Western Railway.	Light rails: of a weight less than 42.5 kgr. or 85 lb, per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb, per yard).	Total,	Number of train-miles: 5 693 088. Total number of fractures: 31,

NAMES		Age of rails :											
OF ADMINISTRATIONS AND	Length of single track vith each rail profile,		5 years and less.						6 to 10 years				
		Year	Number of fractures			ack ss.	ctures km niles.	Year	Number of fractures			,ck	
DESCRIPTION OF RAILS.	Length of with each	of manu- facture.	In the length of the rail.	At the joint.	Total.	Length of single track of this class.	Number of fractures per 1 (100 km or per 625 miles.	of manu- facture.	In the length of the rail.	At the joint.	Total,	Length of single track of this class.	
1	2	3	4	5	Ü	7	8	9	10	111	12	13	
BELGIUM.	Miles.					Miles.						Miles.	
Belgian National Railway Company.													
Light rails :													
of a weight less than 42.5 kgr. per metre or 85 lb. per yard.													
Weight: 38 kgr. (76.60 lb. per yard), profile adopted in 1863 (steel).	124.3					•••	•••	•••					
Weight: 40.65 kgr. (81.94 lb. per yard), profile adopted in 1898.	1 542.3	19 23 to 1927	1	1	2	241.7	5.10	1918 to 1922		4	d	83.9	
Medium rails :													
of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).													
Weight: 50 kgr. (100.79 lb. per yard), profile adopted in 1910.	1 897.7	1923 to 1927	4	11	<i>1</i> 5	1 180.6	7.90	1919 to 1922	5	9	14	452.7	
Weight: 52 kgr. (104.82 lb. per yard), profile adopted in 1886.	254.1	•••		•••								•••	
Heavy rails :													
of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.													
Weight: 57 kgr. (114.90 lb. per yard), profile adopted in 1907.	302.6										•••		
Total	4 121.0	***	5	12	17	•••			5	13	18		

Number of train-miles: 43 658 922. Total number of fractures: 297.

Number of fractures per $10\ 000\ 000$ train-kilometres or $6\ 250\ 000$ train-miles : 42.27.

N, B, — Three fractures due to the silvery oval mark have been identified but there is no doubt that other fractures due to the N, B, — Fractures at points and crossings have not been included in these statistics.

Age of rails:												
14 to 20 years. more than 20 years.									res	oad.		
) Year	Numbe	er of fra	ctures.	77	Number of fractures.			tth track ofiles rs and	ctures p	Total of fracture whole o	axle h	
of nufacture,	In the length of the rail.	At the joint.	Total,	Year of manufacture.	In the length of the rail.	At the joint,	Total.	Length of single track with profiles of 14 years and more.	Number of fractures per 1 000 kilometres, or per 625 miles of these classes.	Total number of fractures for the whole of the system.	Maximum axle load.	
15	16	17	18	19	20	21	22	23 Miles.	21	25	26 Pounds.	
8 to 1914	17	22	39	1898 to 1907	10	1 43	80	124.3 1 216.7	55,00 60.70	11		
0 to 1914	2	34	45	1887 to 1907	21	17	38	264,1 254,1	105 .7 5	74	44 090	
to 1914	11 41	18	29	1907	1 69	78	-18 	302.6	96 5	297		
Percentages of fractures: I. Light rails												

pool sixo mumarit.				17	English tons.	18.2	19.7	19.7	:	or
	20 years.	Number of fractures per 1 000 km. or per 625 miles.		16			8 0 0	:		ilometres
	than	Length of single track of this class.		15	Miles.	6.741	41.767	380.0	48.540) otrain-k
	More	Number of fractures.		14		:	:	:	:	000
	15 to 20 years.	Number of fractures per 1 000 km. or per 625 miles.		13		:	65	:	22	Number of fractures per 10 000 000 train-kilometres or
		Length of single-track of this class.		12	Miles.	2.760	67.314	1.388	71.462	of fracture
		Number fractures.		E		:	10	*	10	ber
rails:	ails:	Mumber of fractures per 1 000 km. or per 625 miles.		10		4 6 0	£.	8 6 9	34	Num
Age of rails	10 to 15 years.	Length of single track of this class.		6	Miles.	3.919	14.509	:	18.428	-
V		Number of fractures.		00		*	-	:		
	Less than 5 years. 5 to 10 years.	Number of fractures per 1 000 km. or per 625 miles.		6		:	:	:	:	•
		Length of this class	No fractured rail was reported.	9	Miles.	:	1.351	:	1,351.	
		Number 10 fractures.	il wa	73		*	:	:	:	
		Number of fractures per 1 000 km, or per 625 miles,	ctured ra	₹ .		į	:	:	. :	
		Length of single track of this class.	No fra	m	Miles.	:	60.833	:	60.833	16.
	Les	Number of fractures.		6%		.:	:	:	:	160 1
	NAMES	ATTONS OF RAILS	Chimay Railway.	1	French Northern Railway (Nord Belge Lines).	Light ralls: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium radis: of 42.5 to 52.5 kgr. per mere (85 to 105 lb. per yard).	Heavy rails: a weight equal to or greater than 53 kgr. per merc or 106 1b. per yard.	Total	Number of train-miles : 2 160 116,
		DI				Jo		of s		

Total number of fractures: 11.

6 250 000 train-miles : 32.

PARTICULARS OF THE FRACTURES.

Medium rails.

Rails from 10 to 15 years of age:

I failure at the joint; clean and new breakage over the whole section of the fracture with silvery oval mark; number of pieces: 2.

Rails from 15 to 20 years of age

- 3 failures at the joint; old fructures much rusted not extending to the outer surface of the head; number of pieces for each fracture;
- I failure at the joint: 2 breakages of which I fresh and clean over the whole section without silvery oval mark and I with old part much rusted not extending to the outer surface of the head; number of pieces; 3,
- I failure at the joint: fracture with old part much rusted extending to the outer surface of the foot; number of pieces: 2,
- 2 failures at the joint: old fractures showing much rusted part extending to the outer surface of the head; number of pieces for each fracture: 2.
- 2 failures at the joint: fresh and clean breakages over the whole of the rail section without silvery oval mark; number of pieces for each fracture
- I failure at the joint: clean and new breakage over the whole section with silvery oval mark; number of pieces: 2

	prop 21	wo mumixoM	17	English tons.	9.8		e s	11	English tons.	13.8	or	
	20 years.	Number of fractures per 1 000 km, or per 625 miles,	16		:	•	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 199,	16		:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 7.7.	
,	than	Length of single track of this class.	lõ		:		000 trai	īč			train-k	
	More	Number of fractures.	4		88	•	000 01 s : 19	14			. 00	
	/ears.	Number of fractures per 1 000 km. or per 625 miles	133		:		ures per train-mile	13		5.5	s per 10 0	
	15 to 20 years	Length of this class.	12		:		er of fract 6 250 000	13	Miles.	330	of fracture 300 train-m	
		Number of fractures.	E		13		Numb	Ξ		34	1ber c	•
rails:	years.	Number of fractures per 1 000 km. or per 625 miles.	01		:			10		:	Nun 6	
Age of rails	10 to 15 y	Length of single track of this class.	6					6		:		
		TodmuM estutarit to	X.		:			×		:		
	ears,	Number of fractures per 1 000 km. or per 625 miles.	1-		:			1-		:		
	5 to 10 years.	Length of single track of this class.	9		:			9	Miles.	106		int. B & 2.
		Mumber of fractures.	ರ		य			20		:		the jour
	years.	Number of fractures per 1 000 km. or per 625 miles.	49.P.C.		:	lles).		4		:		98 miles) outside rouped u
	Less than 5	Length of single track of this class.	က		:	193 mj	.000.	co	Miles.	239	.00.	2 km. (4 occurre i
	Le	Number of fractures.	25		:	ıly (ƙ	3 : 69	63		:	553 5	tures
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	_	Belgian National Light Railway Company. (*)	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	(*) On part of system only (2 193 miles).	Number of train-miles; 21 748 000, Total number of fractures; 697,		CONGO COLONY. Lower-Congo to Katanga Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 1 553 530. Total number of fractures: 2.	Notes Length of system : 802 km. (498 miles). Both fractures occurred outside the joint. The fractures can be grouped under B a ?.

						01 —				
17	English tons.	13.8	or	17	Pounds		51 2 5		51 235	:
16		£	lometres	-16			454.6		:	454.6
li di	Miles.	66.	0 train-ki	55	Miles.		38.277		:	38.277
1,4		90	. 00	14			88		:	82
13		च्युर •	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 48.	13			265.8		:	265.8
63	Miles	- 68.65 - 68.65 - 68.65	f fracture 00 train-m	12	Miles.		65.446		:	65.446
11		τċ	19er o	11			58		:	28
10		99	Num 6	10			426.9		:	426.9
6	Miles	185		6	Miles.		82.149		:	82,149
00		c:		00			26		:	
1-		•		2			195.8		21.4	48.9 56
9		* *		9	Miles.	2	66.633		407.064	473.697
10		:		10			221		14	58
*3°		. 44		*!"			560.0		108.5	121 8
က	Miles.	142	.00	8	Milest,		11.097	9	366.430	377.527
61			841 0 5:45.	63			10		5 1	74
	BULGARIA. State Railways.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 5 841 000. Total number of fractures: 45.	÷	CHINA.	South Manchuria Railway Company.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb, per yard.	Medium rails: of 42.5 to 52.5 kgr.	yer metre (85 to 105 lb, per yard).	

Number of train-miles: 8 842 348. Total number of fractures: 221.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 155.3.

		1					V	Age of rails	ails:							,
NAMES	1	Less than 5 years.	years.		5 to 10 years.	ears,		10 to 15 years.	ears.		15 to 20 y	years.	More	than	20 years	טיין פּוְיִם
ADMINISTRATIONS AND DESCRIPTION OF RAILS	Number 1setures.	Length of single track of this class.	Number of fractures per 1 000 km, or per 625 miles.	Zumber of fractures.	Length of single track of this class.	Number of fractures per 1 000 km, or per 625 miles,	Xumber setures	Length of track of this class.	Yumber of fractures per 1 000 km. or per 625 miles.	Number of fractures.	Length of this class.	Xumber of fractures per 1 000 km. per 1 000 km. or per 625 miles.	Number of fractures.	Length of this class.	Xumber of fractures per 1 000 km. or per 626 miles.	op munitark
-	25	:0	4	5	9	7	∞	5	10	=	12	23	14	5	91	17
DENMARK.		Miles.			Miles.			Miles.			Miles			Miles.		
State Railways.																
Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	0	30,36	, e	€ ŧ	25. 4.1.	e; 6	•	207.76	9.0	, es	233.01	č.	191	8: E	135.0	(a) (b)
Medtum ratis: of 42.5 to 52.5 kgr. per metre (85 to 105 1b. per yard).	, 65	. 38.29	32.55	pul	169.85	<u>ب</u>	0	55.19	c	ଜ୍ୟ	160.44	۶- عز	pril .	89.68	8.9	(<i>d</i> ;
Total	কা	68.65	13.0	m	303.99	6.1	က	262.95	7.1	1 40	393.48	7.9	162	810.90	124.3	
Number of train miles: 12 071 780, Total number of fractures: 175,	2 071 1 : 175	780.			na .		-	Numb trair	er of frac	tures 90.1.	per 10 00	90 000 tra	I in-kil	ometres	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 90.1.	00
(a) 24 250 lb. (45.35 lb. per yard). —	rd)	(b) 2% (b)	(b) 28 660 lb. (64.50 lb. per yard).	1b. pe	r yard).	. (6 33 07	70 lb.	74.59 lb. 1	er yard).	(p) -	33 070 lb	33 070 lb. (74.59 lb. per yard). — (d) 33 070 lb. (90.70 lb. per yard	per y	ard.		

			A									Д						
DESCRIPTION OF	Total number of	Percentag at the joint	oint oint	Percentage of fractures at outside the joint the joint	ires ide oint		(8)	61		,	2	(p)		(5)		Numl rails	$d_{ m j}$ Number of pieces rails broken into	ieces
RAILS.	fractures,	number	per- centage	number	per- centage	number	.per- contage	numper	per- centage	numper	per- centage	numper	per- centage	number	per- centage	two pieces	three	four
	ક્રમ	က	4	rc.	9 .	£-	.xo	6	10		21	13	**	15	91	17	00	61
Light rails:	169	112	66.2	57	33.8	1~	. 4.	44	26.0	48	24.9	17	10.0	29	35.0	150	80	_
Medium rails :-	ය	4.	66.7	60	33.3	0	0.0	က	50,0	rs.	e		16.7	0	0.0	YO.	г	0
Total,	151	116	66.2	62	83 8	1-	4.0	1.4	26.9	4	25.1	18	10.2	29	33.8	155	61.	-
A. — Percentage of fractures in the respective portions of the raits covered by and clear of the fishplates.	fractures in the	e respe	ctive p	ortions	of the	f the rails cove	Sovered	d by an	nd clear	r of the	fishpl	a'es.						

B, - Percentage of fractures according to the appearance of the fracture;

a) Fresh and clean fracture through the whole of the rail section: 1. With silvery oval mark: 2. Nithout silvery oval mark.

b) Fractures, part of which are old and much rusted, extending to the outer face of the foot or head of the rail:

I° When the rusted part is in the foot;
2º When the rusted part is in the head.

c) Fractures with much rusted portions not extending to the outer face of the foot or head of the rail.

d) Number of pieces into which the rail is broken.

	prog a	gwo unuixnjų	17			:	or	17	English tons.	18.85	18.85	1:	-
	20 years.	Number of fractures per 1 000 km.	91			161	of fractures per 10 000 000 train-kilometres 000 train-miles; 190.	16		9.30	39.21	11.68	6 250 000 train-miles: 10.76.
	re than	Length of single track of this class.	Ϊ́	Miles.		79.5	0 train-k	15	Miles.	734.4	63.4	797.8	(Faiti-Ki
	More	Number of fractures.	14			23	- 00	7		1	4,	15	39.
	years,	Number of fractures per 1 000 km. or per 625 miles.	13			300	s per 10 (13		0	1.81	1.81	niles: 10.
	15 to 20	Length of single track of this class.	12	Miles.		3.1	of fracture 00 train-n	22	Miles.	71.5	341.8	413.2 fractures	00 train-n
		Number of fractures.	=			-	ther c	=======================================		0	-	1	250 0
rails:	years.	Number of fractures per 1 000 km. or per 625 miles.	10			62	Number 6 250 (10		:	50 50 50	5.58 Num	9
Age of rails	10 to 15)	Length of single track of this class.	6	Miles.		19.9	-	6	Miles.	:	222.4	222.4	
		Zumber of fractures.	00			€4	-	60		*	₹2	72	
	years,	Number of fractures per I 000 km. or per 625 miles.	7			i		7		:	10	10	-
	5 to 10 y	Length of single track of this class.	9			:	·	9	Miles.	:	124.3	124.3	
		Number of fractures.	īΩ			:		20		:	99	62	
	5 years.	Number of fractures per 1 000 km, or per 625 miles,	4			:		4		:	1.29	1.29	
	Less than	Length of single track of this class.	က	Miles.		26.7	· ·	m	Miles.	•	482.2	482.2	
	7	Number of fractures,	ઢ			:	87 51(8 : 24	83		:	-	123	: 19
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		South Funen Railway.	Light ratis:	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 787 510, Total number of fractures: 24,		EGYPT. State Railways,	Light ratis: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total	TOTAL MUMOCI OF HEAVILED

	Remarks.	ę			Stock rail			SUCCK FAIL	Stock rail	Stock rail			· Stock rail						
Irves,	Age,	ഹ			: :	:	:	: :	:	22	÷	:	:. 6	3,6	:	:	:	:	-
On curves.	Number.	41		:	:	:	:	: :	:	7	:	:	: -		:	:	:	:	-
traight.	Agc.	m		က	8	10	हां ह	16	21	:	7.5	53	02 ::	:	33	36	37	37	
On the straight.	Number.	34		1	-	~ ,	, - ,	F	-	; .	-	_ c	·	:		61	1	60	
TYPE OF BAILS		,	EGYPT.	State Railways.		Flat 47 kgr. (94.75 lb. per yard)				Flat 46 kgr. (92.73 lb, per yard)		Flat 42 kgr. (84.67 lb. per yard).			Flat 37.4 kgr. (75.39 lb. per yard)			Flat 36 kgr. (72.57 lb. per yard)	Percentage of fractures at the joint : 4.76 %

	p	מן ביום	o mumixoN	1,	English		<u>ئ</u> من		11	English tons.	20	es	
	A THE STREET STREET	20 years.	Number of fractures per 1 000 km. or per 625 miles.	ίċ			:		16		17	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 490.	
	1000	than	of single track of this class.	15	Miles.		981		15	Miles.	483	000 trai	
		More	Number of fractures.	14			್ತ		14		168	10 000 s : 49	<u>e</u>
1		20 years	Number of fractures per 1 000 km. or per 500 km.	13			:		13		:	of fractures per 10 000 (250 000 train-miles: 490	he rail: the head
		15 to 20 y	Length of this class,	12				of fractures: 5.	12		:	mber of fract	nead of t
			Number of fractures.	Ξ			:	of fr	Ξ		:	(ump	or fa
of rails:		rears.	Mumber of fractures per 1 000 km, or per 625 miles,	01			*	Total number	10		:	4	ie flange ace of the
Age of	200	10 to 15 years.	I.ength of single track sease.	6			*	Total	6		:		ice of the
			rodmuX sorutoril lo	æ			. :		30		:		m: surfe
		10 years,	Number of fractures of fractures per 1 000 km. or per 625 miles.	ţ		•	*		-		:		the sectionail: outside 73.
		5 to 10 y	Length of single track of this class.	9			. :		9				rance of of the referrall; 1. extending
			Number 10 tactures.	5			Classic Control of the Control of th		10		:		ppea ction endin of f the
		years.	Number of fractures per 1 000 km, or per 625 miles,	4					4	,	:		to the swhole section. The section is section. The section is section. The section is section.
		Less than 5 years	Length of single track of this class.	202					62		:	3.	according over the coval may ovel may ovel may ovel may ovel may ovel may ovel a suc in the acc in
_		دّ	Number of fractures.	2			:	695 804.	3/2		:	128 8	ures eak ilvery it silv surf surf old
		NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		SPAIN.	Central Aragon Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	iles :	-	Madrid to Caceres and Portugal and West of Spain Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 2 128 800. Total number of fractures: 168,	Note: B. — Percentage of failures according to the appearance of the section: a) New clean break over the whole section of the rail: 2. Without silvery oval mark: 81. 2. Without silvery oval mark: 8. b) Fracture partly odd and rustled extending to the outside surface of the flange or head of the rail: 2. Rusted surface in the flange of the rail: 73. c) Fracture with old and rusted surface and extending to the exterior surface of the flange or of the head of the rail: 5.

17	Pounds		35 275	35 275	:				soes	the ken.	Ī
16	<u>a</u> ,	4.	67.72		67.72	me res or			d) Number of pieces	into which the rail was broken.	63
15	Miles.		137.6	:	137.6	train-kilo					
14				:	55	000 00		on.	ld and	xterio ange or an rail	
21	ears :		si .	28.0	0.92	per 10 00 les : 7.61,	section	f the secti	e with o	tending to the exterior surface of the flange or of the head of the rail.	5.88
12	to 20 years:	Miles.	:	1 348.3	1 348.3	Number of fraciures per 10 000 000 train-kilome res or 6 250 000 train-miles: 7.61.	f the	earance of	c) Fracture with old and rusted surface not ex-	surface of the	
11	ಸರ		:	જ	€ ર	250 00	ce o	е арр		sur- lead	
10	.e-		:	:	:	Num 6	ppearan te Railu	B. Percentage of failures according to the appearance of the section.	b) Fracture partly old and rusted extending to the outer surface of the flange or head of the rail.	2. Rusted surface in the head of the rail.	:
6			:	:	:	·	ne a lican	s acco	artly c		
<u>~</u>			:	:			to tl	failure	ture prendinge of the rail.	of of	99
7			: .	*	:		rding ossa ar	intage of	b) Frac	face in the flange of the ruil.	47.06
9			:	:	:	19	the fractures, according to the appearance of the section (Madrid, Saragossa and Alicante Railway).	B. Perce	a) New clean fracture over the whole section of the rail.	2. Without silvery oval mark.	47.06
70			_!	:	:		nctur		acture of the	2. Silv	*
4			:	*	:		the fre (Ma		clean fra	Vith silvery oval mark.	
σ'n	Miles.		:		:		Particulars of		a) New whol	l. With silvery oval mark.	•
2					:	13 882 ss : 17	cula	the	rt of late)		
		gossa and iilway.	ils: an 42,5 kgr. re yard.	dis: 5 kgr. r yard).	Total,	ain-miles : r of fracture	Parti	failures at	ay in the pa by the fishp joint,	Outside the joint.	100.0
-		Madrid, Saragossa and Alicante Railway.	Light rails: of a weight less than 42.5 kgr. or 85 lb, per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (55 to 105 lb. per yard),		Number of train-miles: 13 882 933. Total number of fractures: 17.		A. Percentage of	joint that is to say in the part of the rail covered by the fishplate) and outside the joint,	At the joint,	:

	proj ejs	xv unuqa op	17	English tons.	7.		37 480	37 480	:	
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	16		136		37.80	:	0 0	ıc
	than	Length of single track search sidt to	lò	Miles.	109		1 167	:		lometres
	More	Xumber of fractures.	14		24,1)		7		11	in-kij
	years.	Number of fractures per 1 000 km. per 1 second con ten.	13		:		0.53	0.80	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-niles : 33.
	15 to 20 y	Length of single track of this class,	12	Miles.	. :		1 167	1 552	:	s per 10 (miles : 33.
		Xumber of fractures.	=		:		~	S+	က	cture
rails:	rears.	Number of fractures per 1 000 km. or per 625 miles.	01		:		1.06	2.00	:	ber of fra 250 000 ti
Age of rails	10 to 15 years.	Length of single track of this class.	6	Miles.	;		1 167	1 552	:	Num 6
		Number of fractures.	œ		:		æ	ەت	5-0	
	10 years,	Number of fractures per 1 000 km. per 1 second cm.	7		:		*	1.20	•	
	5 to 10 y	Length of single track of this class.	9	Miles.	:		**************************************	1 552	*	,
		Number of fractures.	ಸ		:		:	m	60	
	years.	Xumber of fractures per 1 000 km, or per 626 miles.	7	•	:		;	6.40	:	
	Less than 5 years.	Length of single track of this class,	3	Miles.	. :		*	1 552	•	18 579 991 00,
	اد	Number of fractures,	2		:			16	16	s : 10
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		Medina del Campo to Zamora and Orense to Vigo Railway.	fight rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	North of Spain Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb, per yard.	Medium ralls: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total	Total number of train-miles: 18 579 991, Total number of fractures: 100,

(4) Of the 24 fractures, 3 occurred at the part of the rail covered by the fishplate and the other 21 outside the joint,

17. Pounds		Pounds	70 000	70 000	roken	Per cent.	15.7 4.8 4.8 15.9 0.3	100.0	ress, nt of
. 16	vin-kilome E. rail	91	81	;	lge of b			of 929 o	on Cong
15 Miles.	S. C. F	10	100	:	percent	Number.	23.4 7.2 23.7 10.8 45.3 4	1 494 u total rails.	degree
14	10 000 0 3 : 255.	4	13	:	• w the		ead at	and D , broken	d by the
<u> </u>	ain-miles	ವ	469	:	ubles sho		bars.	A, B, C eport as	y adopte
ei :	Number of fractures per 10 000 000 train kilometres or 6 250 000 train-miles : 255. Rolled : 1908-1912. A. S. C. E. rail	Miles.	171	:	owing ta	100 lb. per yard rail.	Plain clear breaks outside splice bars. Transverse fisances outside splice bars. Diagonal breaks inside splice bars. Diagonal breaks through web and head split webs outside splice bars. Crushed and split heads.	Failures classed under headings A, B, C and D, a total of 929 all failures, are included in the report as broken rails.	summar ssures a
= :	(umber or 6 % Ro		133	:	The follower of	per ya	s outsices outsices inside through	 under h cluded	e final rerse fi
9 :		3 .	252	:	report.	100 lb.	ar break se fissur ur break breaks s outsid und split uses	classed s, are in	ed in there or transv
o :	Rolled: 1913\1917.	Miles.	735	:	in this location		Plain clear breaks outside spli Transverse fissures outside spli Plain clear breaks inside splice Diagonal breaks through we joints Split webs outside splice hars. Crushed and split heads.	Total Failures I failure	s contair n rails c
∞ :	Rol		297	:	cluded to the		4. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5. 5.		uctions broke
. :	8-1922.		149	9	ve been in according	Per cent.	14.9 14.9 1.0 1.0 2.0 2.9	30.7 %	h the instr sub-divide
· ·	Rolled: 1918-1922.	Miles,	797	84	ails har			of 64 or	nce wit
то :	Roll		190	∞	100 lb.	Number.	51.E. 4.4.E.	a total c	accorda ch deta
4	3-1927.		103	89	und 929 them in		iead at	and D,	en is in pt in su
en :	17. Rolled: 1923-1927. 2 3 4	Miles.	1 799	505	divides		e bars. Se bars. bars and land bars.	A, B, C	been ke
61	414 785 : 17. Roll		536	26	130 n d also	rd rail	splice splice splice web splice	adings the r	anures e not
Great Southern of Spain Railway. Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train miles : 414 783. Total number of factures : 17. Rolle	UNITED STATES OF AMERICA. Baltimore and Ohio Railroad.	100 lb. per yard rails.	130 lb. per yard rails.	It will be noted that 64 130 ib, rails and 929 100 ib, rails have been included in this report. The following tables show the percentage of broken rails to all failed rails, and also divides them into four classes, according to the location and nature of the break:	130 lb. per yard rail	A. Plain clear breaks outside splice bars. B. Transverse fissures outside splice bars. C. Plain clear breaks inside splice bars. D. Dugonal breaks through web and head E. Split web failures outside splice bars. F. Crushed and split brads.	Failures classed under headings A , B , C and D , a total of 64 or 30.7 %. The classification of the failures	except that the records have not been kept in such detail as to sub-divide broken rails or transverse fissures according to the degree or extent of the oxidization.

Number of single track Number Maximum axle load, of fractures, of per 625 miles.	Rails less than 5 years of age.	Rails 5 to 10 years of age.	16 . 270 37 61 700	Rails 10 to 15 years of age. None.	ge.		– age.
NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS	Central of Georgia Bailway. Medium rails:	Medium rais:	85 lb. to 105 lb. per yard		Medium rasis :	85 lb, to 105 lb, per vard	

	proof 97	an munixaM	17	Pounds	±75 000	ır	17	Pounds	63 700	63 700	63 700		5		
	20 years.	Number of fractures per 1 000 km, or per 625 miles.	91		:	ilometres	16		:	:	:		or 6 25 0 000		e records
	than	Length of single track of this class,	15		:	0 train-k	15		:	:	:		train-kilometres		from th
	More	Number of fractures.	14		:	0000	14		:	:	:		in-kilo		able
	years,	Number of fractures per 1 000 km, 10 per 625 miles	13		: .	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 289.	13		710	:	710		100 000 tra		not avail
	15 to 20	Length of single track of this class,	12		:	of fractur 000 train-	12		59	:	Ge		s per 10 0		on II is
		Number of fractures.	=		:	3 250	11 1		67	:	67		stures 363.		secti
rails:	15 years.	Number of fractures per 1 000 km, or per 625 miles.	01		550	Nun	10		884	:	824		Number of fractures per 10 000 000 train-miles: 363.	overed by fishplates: 14.5. clear of fishplates: 85.5. with silvery oval mark: 31.7. without silvery oval mark: 68.3.	l under
Age of	10 to 15 y	Length of single track of this class,	6		67		0	Miles	300	i	390		Num ¹ trai	covered by fishplates: S5.5. clear of fishplates: 85.5. with silvery oval mark. without silvery oval ma	edneste
		Number setures.	20		59		00		552	:	552			ered ar of h silv hout	hat 1
	10 years,	Number of fractures per I 000 km. or per 625 miles.	1		128	-	7		352	:	352			Percentage of breakage covered by fishplates: 14.5. — clear of fishplates: 85.5. — with silvery oval mark: 31. without silvery oval mark:	ired, as t
	5 to 10 y	Length of this class,	9	Miles.	383		9	Miles.	1 395	:	1 395			ge of bre	ion requ
		Number of fractures.	ರ		20		iG.		785	:	785			centa	rmati
	years.	Number of fractures per I 000 km, or per 625 miles.	4		139	-	4		115	21	103			Per	the info
	Less than 5	Length of single track of this class.	20	Miles.	340	90 000°. 35°.	63	Miles	2 107	560	2 367	1927.	3 354. 793.		ce all of
	Ë	Number easutagnt fo	8		2.6	1 4 0 1 : 13	84		379	10	386	nber	30 858 s : 1		nbra
-	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	Dolowon ond Hudgen	Railway.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 1b, per yard).	Number of train-miles: ± 4 000 Total number of fractures: 185,	1	Illinois Central System. (*)	90 lb. per yard ARA-A rails.	110 lb. per yard R. E. rails.	Total	(*) Year ending 1 November 1927	Number of train-niles: 30 858 354 Total number of fractures: 1 793.		This report does not embrace all of the information required, as that requested under section II is not available from the records.

	מופ וסמק	ov mumixoll	1	Pounds	200		17	Pounds	73 000	
				Por	8	or .	_	Por	33	or
	20 years.	Number of fractures per 1 000 km, or per 625 miles.	16		180	ilometres	16		:	ilometres
	than	Length of single track of this class.	15	Miles.	8	00 train-k	范		:	O train·k
	More	Number 10 fractures.	14		R	000	14		:	8
	years.	Number of fractures per 1 000 km, or per 625 miles,	13		120	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miløs : 186.	13		0 0	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 172.
	15 to 20 years.	Length of single track of this class,	12	Miles.	240	of fracture				mber of fractures per 10 (6 250 000 train-miles : 172
		Number serutes.	Ē		46	1ber 3 250	p=1		:	ber 6
rails:	ears.	Number of fractures per 1 000 km, or per 625 miles.	10		154	Num	10		63	Num
Age of rails	10 to 15 years.	Length of single track of this class.	6	Miles.	69		6	Miles.	4	
		Number of fractures.	ώ		11		20		2,3	
	ears.	Number of fractures per 1 000 km. or per 625 miles,	1		99		7		197	
	5 to 10 years.	Length track of this class.	9	Miles.	170		9	Miles.	8	
		Number of fractures.	70		200		10		22	
	s years.	. Number of fractures per 1 000 km, or per 625 miles.	4		17		4		0	
	Less than 5 years	Length of single track of this class.	m	Miles.	264	.77.	m	Miles.	27	÷.
	ٽ	Number of fractures.	3-5		en	3 603	65		0	- 13 - 13 - 13
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	,	Kansas City Southern Railway.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Number of train-miles: 3 603 000, Total number of fractures: 107,		Lehigh & New England Railroad.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb, per yard);	Number of train-miles: 545 797, Total number of fractures: 15,

	.bool 91	wo unuixvy .	17	Pounds			68 330		68 330	68 330		
	20 years.	A imber of fractures per 1 000 km, or per 500 km, or per 625 miles.	91	щ			:		.:	:	-	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 24.1
	than	Length of this class.	15	Miles.			:		:	:		train-kil
	More	Number of fractures.	14				:		:	<u>:</u>	-	000 00
	years.	Number of fractures per 1 000 km, or per 625 miles.	13		•		154.32		440.14	÷	-	er of fractures per 10 000 250 000 train-miles : 24.1
	15 to 20	Length of this class.	31	Miles.	•	,	4.05	-	1.42	:		f fractures 000 train-n
		Number of fractures.	=_						7	:		ober 0
of rails:	15 years.	Number of fractures per 1 000 km, or per 625 miles.	01				46.96		11.95	525.21		Num
Age of	10 to 15	Length of single track of this class.	6	Miles.	_		146,40		:	1.19	_	
		Number fractures.	20				Ξ		:			ŕ
	10 years,	Number of fractures per 1 000 km, or per 625 miles.	L				29,49		_;	43,35		- 1
	5 to 10 y	Length of single track of this class.	. 9	·	,		42.39		:	259.52		
		Number of fractures.	ro.				63		:	18		
	years,	Number of fractures per 1 000 km, or per 625 miles,	4		·		:	-		10.72	er 1927.	
	Less than 6	Length of single track of this class.	S. Miles				. !		:	524.95	31 Octob	733.
	1	Number of fractures.	2				:		:	σ.	6 to	: 43.
	NAMES OF	ADMINISTRATIONS AND DESCRIPTION OF RAILS	-	Lehigh Valley	Railroad. (*)	Medium rails:	100 lb. per yard rails.	Heavy rails:	110 lb. per yard rails.	136 lb. per yard rails.	(*) From 1 November 1926 to 31 October 1927.	Number of train-miles: 11 117 733. Total number of fractures: 43.

	proj 11/2	ор шпицхр ү	18	Pounds	65 000	:	57 200	000 +9	65 000		78 000	:	62 000	57 200	64 000	65 000 78 000	:	S	
) years.	Number of fractures per 1 000 km. or per 625 miles	15		78.12	:	246.69	312.00	55.38	:	:		:	* * * * * * * * * * * * * * * * * * * *	:	: :	:	Number of fractures per 10 000 000 trains-kilometres or 6 250 000 train-miles,	
	More than 20	Length of single track of this class.	li	Miles	8.00	:	124.14	38.70	79.00	: :	:	0 0	*		:	: :	:	Number of fractures 10 000 000 trains-kilomor or 6 250 000 train-miles.	45.34 17.80 No data.
	Mar	Number of fractures.	et et		: -	:	49	19	-	:	:	:	:	:	:	: :		umbe 000 (
	years.	Number of fractures per 1 000 km. or per 625 miles.	14		46.00		39.27	138.00	109.27	:	158.15	:	:	70.26	:	: :	:	per 10	
	15 to 20 y	Length frack track single track to single track.	13	Miles.	417.40	7.26	31.83	127.90	143.00	:	19.76		*	17.79	:	: :	:	Total number of fractures.	22 41 23 63 55 61 61 61 61 61 61 61 61 61 61 61 61 61 6
		Number of fractures.	12		31	;	જ	28	- S	:	2	:	:	Ø1	:	: :		rotal y	
ails:	ears.	Number of fractures per 1 000 km. or per 625 miles.	11		40.00	22.00	:	160.00	137.00	:	390.28	0 0 0	1	51.65	:	: :	:		Erie ati,
Age of rails	10 to 15 years	Length of single track of this class.	10	Miles.	365.45	56.60	:	451.43	348.00		22.42	:	:	48.41	:	: :	:	ROAD.	Pittsburg & Lake Erie, Cleveland, Cincinnati, Chicago & St. Louis Michigan Central
V		Number setures	5		31	70	:	123		:	14	:	:	41	:	: :	:		Pittsburg Cleveland, Chicago Michigan Rutland
	years,	Number of fractures per 1 000 km, or per 625 miles,	00		38.00		:	60.00	87.00	110.50	:	24.16		8,28	:	12,15	*		Pitt Cler Mic Rut
	5 to 10 y	Length of single track of this class.	Į	Miles.	352.35	0 0	:	999.85	122.70	118.75	:	805.00	526.09	75.46	:	102.90	:		
		Mumber of fractures.	9		22	*	:	96	17	21	:	3]	.145	_	:	: 64	:		
	years.	Number of fractures per 1 000 km, or per 625 miles,	ū		195.00	:	:	58.00	12.00	142.10	:	7.98	40.80	14.64	49.00	2.27	:	es ometres les,	
	s than 5	Length of singlo track of this class.	4	Miles.	67.47	:	:	1 565.20	265.99	334.44	:	783.00	612.82	128.02	366.13	275.49	:	Number of fractures 10 000 000 trains-kilome or 6 250 000 train-miles.	91.00 28.55 51.00 106.20
	Less	Number of fractures.	30		: 23	:	:	149	0 20	92	:	10	40	20	23	<u> </u>	:	nber 0 0 000 50 000	5 % E &
		ROAD.	7		New York Central-East . New York Central-West.	o. c. Lines.	Kutland	New York Central-East	New York Central-West.	27	Pittsburgh & Lake Erie.	Cleveland, Cincinnati, Chicago & St. Louis.	Michigan Central	Kutland	New York Central-East .		Michigan Central	Total number of fractures.	88 833 97 83 84
	NAMES	ADMINISTRATIONS AND OESCRIPTION OF RAILS.		New York Central Lines.	Light rails:	than 42.5 kgr. per metre	or so to, per yard.				Medium rails:	(85 to 105 lb. per yard).			Heavy rails:	of a weight equal to or greater than 53 kgr. per metre	or 100 to, per yard.	ROAD,	New York Central-East New York Central-West New York Central - 0. C. Lines Boston & Albany

6 Load	1xv unwixth	17	Pounds	Steam comotives : 68 000.	100	Electric comotives : 75 000.	0[17	Pounds	2 300	009 9	009				pieces.] ·E ·
Irs.	of fractures per 1 000 km. or per 625 miles.	-	<u>ч</u>		_	7, 4-14		250 000	inco.	PC		75	75		38 OF		11 pie	0.01
) years	Number of fractures	16		5.4	0	0	5.4	or 6 250	16		514.7	240.8	:	334.3	metre		e es.	
than 20	Length of single track of this class,	15	Miles.	231	0	0	231		15	Miles.	453,56	16:000	0.25	1_	rajn-kilo		s. 10 piec	
More	Number of fractures.	14		R	0	0	62	n-kilom	14		1197 1 4	1186 3 00	:	2383 4 454.72	00 000 t		9 pieces.	001
20 years,	Number of fractures per 1 000 km, or per 625 miles.	13		12 6	33.7	0	20.3	per 10 000 000 train-kilometres	13		879.5	443.1	:	486.2	of fractures per 10 000 000 train-kilometres 000 train-miles: 418.02.		8 pieces.	20.00
15 to 20	Length of single track of this class.	12	Miles.	198	130	0	328		12	Miles.	156.85	1 769.05	93.0	1 926.85	f fracture 30 train-m	into	pieces.	0.01
	Number of fractures.	=		. , 4	~	С	=	sture:	11		227	1272	:	14991	her o	Broken into		
ars,	Number of fractures per 1 000 km. or per 625 miles.	10	ئىد	0	81.9	0	81.9	Number of fractures train-miles: 66.7.	10		238.4	411.3	513.8	432.6	Number 6 250 (Bro	6 pieces.	0.04
10 to 15 years.	Length of this class.	6	Miles.	0	290	0	290	Numb	6	Miles.	26.22	297.74	757.98	2133 3 081.94			5 pieces.	0.03
	Number of fractures	20		0	38	0	88		∞		10	512	611	133/3			pieces	4:28
ars,	Number of fractures per 1 000 km. or per 625 miles.	-			19.2	39.1	22.5		7		:	332.7	358.3	351.1			4	0.04
to 10 years.	Length of track of this lossis.	9	Miles.	10	487	96	583		. 9	Miles.	:	691.27	753.13	1373 2 444.40			3 pieces.	0 18 6.14 2.91
20	Number of fractures.	5		0	55	9	21		20		:	368	1005	373 2			pieces.	2.13 47.10 39.96
years.	nodmul. sorutant to tractures ,md 000 troq ,md 623 roq ro	4		0	14.7	18.7	17.71		4		:	55.7	79.6	73.3			<u>∾</u>	
Less than 5 years.	Length of this lost.	6	Miles.	. 0	297	903	1 200	158.	9	Miles	÷	1184.65	385 3 021.81	206.46	69 2. 881.	Fractures	with silvery oval mark.	6.03 3.93
Les	Number of fractures.	87		0	F-0	27	34	5 8 9 7	63		:	108	385	493 4 206.	7 832	Frac		
	FIONS F RAILS		Western ay.	metre	ls: metre (ard).	r metre (ard).	Total	in-miles : 1; of fractures		ailroad.	: 42.5 kgr. rard.	kgri.	to or per metre		n-miles : 11 of fractures		in joint.	11.95 36.10 18.17
NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAI		Norfolk & We	Light rails: of 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 49.60 kgr. per metre (100 lb. per yard).	Heavy rails: of 64.50 kgr. per metre (130 lb. per yard).	T	Number of train-miles: 15 897 Total number of fractures: 106,		Pennsylvania Railroad	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr., per metre (85 to 105 lb., per yard).	Heavy rails: of a weight equal to or greater than 52.6 kgr. per metre or 105.2 lb. per vard.	Total.	Number of train-miles: 117 832 692. Total number of fractures: 7 881.			Light rails: Medium rails: Heavy rails:
										-								

	ppoj ə	Naximum axi	17	:	:	:		Pounds 69 900	006 69	:	or
	20 years.	Number of fractures per 1 000 km. per 1 000 km.	16	:	:	:		:	:	. :	lometres
	than	Length of this class.	lõ	. :	:	:		:	:	:	l 0 train-k
	More	Number of fractures.	4.	:	TC.	:		:	:	1 :	- 00
	20 years.	Mumber of fractures per 1 000 km, or per 625 miles	13	:	:	:		:	:	**	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 39.
	15 to 20	Length of single track of this class.	12	:	:	:		:	:	:	of fracture 000 train-
		Number of fractures.	=	:	~	i		:	:	1 :	ber c
rails:	years.	Number of fractures- per 1 000 km. or per 625 miles.	10	:	:	:		:	:	:	Num
Age of rails	10 to 15 years.	Length of single track of this class.	6	:	:	:		:	:	:	-
		Mumber of Itactures.	∞	:	ನ್ನ	:		:	:	:	
	ears,	Number of fractures per I 000 km, or per 625 miles,	1-	:	:	:		70	:	7.0	
	6 to 10 years,	Length of stack of this class.	9	:	:	:		Miles.	:	120	
		Number of fractures.	ည	. :	14	4.		4	:	1 77	
	years.	Number of fractures per 1 000 km. or per 626 miles.	4	:	:	:		39	0	18	
	Less than 6 years.	Léngth of single track of this class,	က	:	;	:	•	Miles.	75	105	<u></u>
	ı	Number of fractures.	2		က	9		63	0	m	: 17.
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	Donding Con-	of a weight less than 42.5 kgr. or 85 lb. per yard.	Medium rasis: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.	Richmond, Fredericksburg and Potomac Railroad.	Medium ratts: of 42.5 to 52.5 kgr. per metre (85 to 105 10, per yard).	Heavy rails: ofa weight equal to or greater than 53 kgr. per metre or 106 15. per yard.	Total	Number of train-miles: 2 725 143. Total number of fractures: 17.

				-,								
17 Pounds	67 500	67 500	67 500	:	or		17	English tons.	14.8	8.4.	:	
16	247	147	. :	241	lometres	-	16		47.3	:	47.3	metres
15 Miles.	920.3	55.3	:	975.6	,) train-ki		I5	Miles.	2 504	:	2 504	train-kilo
14	364	13	:	377	000 000 8.		14		191	:	191	000 00
13	901	17.1	:	167	s per 10 miles: 23		13		23.6	, :	23.6	per 10 0
12 Miles.	29.6	179.3	:	208.9	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 238.	0. 0.	12	Miles.	341	:	341	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 141.
11	in.	70	:	26	ber of 6 250	47.0 °/, 53.0 °/,	=		13	:	13	er of 50 000
10	:	172	:	171	Num	267 — 47.0 %:	10		4.	:	1.2	Numb 6 2
9 Miles.	1.4	268.9	:	270.3		Number of fractures occurring in splice : $267-470\%$ Number of fractures occurring out of splice : $301-53.0\%$	6	Miles,	426	7.5	498	
00	:	74	:	74	•	ng in ng out	00		prod	:	-	
1-	:	. 58	:	58		s occurri	7	,	26.1	:	1.71	
6 Miles.	:	357.9	:	357.9		Number of fractures occurring in splice : Number of fractures occurring out of splic	9	Miles.	190	100	068 .	
70	:	33	:	<u> </u>		ber of ber of	70		, 50	:	00	
41	:	т	13	28		Num	पा		117.5	66.3	100.3	
3 Miles	:	380.8	242.7	623.5	245.		3	Miles.	259	131	390	
82	:	23	TO.	233	14 903 s : 569		82		67	4.	63	158 3
1 Wabash Railway.	Light rails: I a weight less than 42.5 kgr. per metre (85 to 105 lb. per yard).	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 1b, per yard).	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.	Total	Number of train-miles: 14 903 245. Total number of fractures: 568.		1	FINLAND. State Railways.	Light rails: of 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb; per yard).	Total	Number of train-miles; 12 158 350. Total number of fractures: 276.

osd.	l slxs mumixsM	9 English tons.	19.7	19.7	19.7	**	550 000
Number	fractures per 1000 km. or per 625 miles.	∞	œ	\$\$:	e e e	kilometres or 6
	Length of single track.	7 Miles,	5 670	28 384	%	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles; 56.
	More than 20 years.	¢	220	₹G	:	33. \$4.	of fractures per iles : 56.
	15 to 20 years.	io	& ,	22	:	ోగ	Number of fractitrain-miles : 56.
Age of rails:	5 to 10 years. 10 to 15 years. 15 to 20 years.		:	ıo	:	иэ	
	5 to 10 years.	.m	pnd	63	:	က	
	Less than 5 years.	es.		9 0 0	:		800 815.
NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS.	I FRANCE. State Railways.	Light rails: of a weight less than 42.5 kgr. per m. or 85 ib, per yard	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb, per yard),	Heavy rails: Standard 55 kgr. per metre (110.87 lb. per yard).	Total . ; .	Number of train-miles: 40 800 815. Total number of fractures: 368.

Неипу.		None.		11 pieces	- : :
		<i>(</i> -4		6 pieces	* ! !
Medium Per cent.	13.0	5.4	53.3	5 pieces.	- : :
	:			4 pieces	rò ex :
Light.	4.6	21.7	25.1	3 pieces.	10 t- :
<u> </u>	ark al mark		:	2 pieces.	251
	with silvery oval m without silvery ov	in the foot.	•	<u>!</u>	light
	3. — a) Fresh and clean fracture in the whole of the rail section.	b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	c. Fracture part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail		d) Number of pieces into which the rail is broken
		a) Fresh and clean fracture in the with silvery oval mark 9.4 13.0 without silvery oval mark 29.7 16.3	A Fresh and clean fracture in the with silvery oval mark. b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail.	b) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot c) Fracture part of which is old and much rusted, or the head of the rail c) Fracture part of which is old and much rusted, or extending to the outer surface of the foot or the head of the rail c) Fracture part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail c) Fracture part of which is old and much rusted, not extending to the foot or the head of the rail c) Fracture part of which is old and much rusted, not extending to the rail c) Fracture part of which is old and much rusted, not extending to the rail c) Fracture part of which is old and much rusted.	Fresh and clean fracture in the with silvery oval mark. b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail

	a toad.	er unuixvii	17	English	7.81 84 : 18.3.	For vascons:	:	
	20 years.	Number of fractures per 1 000 km. r per 625 miles.	1 16		37	20	88	etres or
	than	Length of thack of this class.	15	Miles.	1 201	08	1 281	ain-kilom
	More	Number of fractures.	14		17	1-	00	
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	13		82	Ş	33	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 45.
	15 to 20	Length of single track of this class,	37	Miles.	176	. 171	347	umber of fractures per 10 6 250 000 train-miles : 45.
		Number of fractures.	=		00	10	1 82	of fr: 300 tr
rails:	years.	Mumber of fractures per 1 000 km per 1 625 miles	01		. 22	124	57	Number 6 250 (
Age of rails	10 to 15 years.	Length of single track of this class.	6	Miles.	. 180	08	260	
		Number of fractures	20		00	16	15%	
	10 years,	Number of fractures per 1 000 km. or per 625 miles.	7		e e e	t-	9	
	5 to 10 y	Length of single track of this class,	9	Miles.	14	WC 00	8	
		Number of fractures.	ಣ		i i	-	-	
	5 years.	Number of fractures per 1 000 km, or per 625 miles,	77"		:	es .	61	
	Less than	Length of single track to the contract of the	က	Miles.	:	295	293	٠
	ĭ	Number setures.	3×			-		974 6
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	-	Alsace and Lorraine Railways (including the Guillaume-Luxembourg	Light rails: of a weight less than 42,5 kgr. per metre or 85 15, per yard.	Medium rasis: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total	Number of train-miles: 16 974 675, Total number of fractures: 122,

Note. - This table does not include broken machined rails in points and crossings, that is to say, those of the nose, wing rads, points and stock rails.

Percentage; Clear of the fishplates. 25.3 8.6	Heavy.		None.			8 pieces	: " :
	Medium.	, Per cent. 14.3 8.6	6. 4. c.	37.1		4 pieces	⇔ n ;
A Fractures of light rails - medium	Light.	Per cent. 11.5	13.8	8.18		3 pieces	6 ::
Percentage: Covered by the fishplates, 74.7 91.4		with silvery oval mark without silvery oval mark .	ot			2 pieces	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
the		~~	in the foot.	in the web	L		light medium .
A. — Fractures of light rails		Fresh and clean fracture in the whole of the rail section.	Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail.	Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail			d) Number of pieces into which the rail is broken.
*			(9	<u>©</u>			q)

	ppoj əjx	vo unuşxvjy	17	English tous.		18.9		
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	16		155	4 963	:	348
	than	Length of single track of this class.	15	Miles.	24.000	1.002	:	25.002
	More	Number of fractures.	14		9	20	:	74
	20 years.	Number of fractures per 1 000 km. or per 525 miles.	13		0	184	*	90 90
	15 to 20 y	Length of single track of this class.	12	Miles.	18.722	3.377	0 0 0	22.099
		Number setures.	=		0	-	:	
ails:	ears.	Number of fractures per 1 000 km, or per 625 miles,	10		e	109	e e e	£5
Age of rails	10 to 15 years.	Length of single track of this class.	6	Miles.	2.825	5.708	***************************************	8.533
W		Number setures	∞		0	_	:	
	ears.	Number of fractures per 1 000 km. or per 625 miles.	7		0	0	0	0
	5 to 10 years,	Length of single track of this class.	9	Miles.	1.448	21.255	548	23.251
		Number sectures.	5		0	0	i	0
	years.	Number of fractures per 1 000 km, or per 625 miles,	4		0	0	0	0
	Less than 5 years	Length of single track of this class.	273	Miles.	0.970	46.092	2.367	49.429
	Les	Number of fractures.	2		0	0	0	0
	NAMES	AATIONS OF RAILS		Paris Circle Railways. (*)	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb, per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Heavy rails: of a weight equal to or greater than 53 kgr, per mere or 106 ib, per yard.	Total

(*) Broken rails (excluding those in points and crossings).

Number of train-miles; 1 666 665 Total number of fractures: 16.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 59.6.

Percentage: Clear of the fishplates, 33.33	Heavy.		None.		3 pieces.	es :
	Medium.	Per cent.	30	09		
A Fractures of light rails medium heavy .	Light,	Fer cent 33.33	16.67	16.67	2 pieces.	70 t- :
Percentage: Covered by the flashplates. A. — Fractures of light rails		B. — a) Fresh and clean fracture in the with silvery oval mark whole of the rail section without silvery oval mark .	much rusted, extending to the outer surface of the foot or the head of the rail in the head in the hea	c) Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail.		d) Number of pieces into which the rail is broken

	ופ ניומע	xv unuixvy	12	English		18.3	tives).		
	20 years.	Number of fractures per 1 000 km, or per 625 miles,	16	E	75.8	61.2	:	71.2	
	than	Length of single track of this class.	15	Miles.	2 665 1	1 218.5	:	3 883.6	-
	More	Number 10 fractures.	14		325	୍ଷ	:	445	
	years.	Mumber of fractures per 1 000 km, or per 625 miles.	13		:	38.4	•	25 25	•
	15 to 20)	Length of single track of this class.	112	Miles.	162.8	436.2		599.0	
		Number of fractures.	E		:	27	:	27	
rails:	15 years.	Number of fractures per 1 000 km.	10		5.33	19.4	* *	16.1	
Age of rails	10 to 15 y	Length of single track of this class.	6	Miles.	84.5	223.7	* *	308.2	
		redinnal seritses	20			t-	:	20	
	years.	Number of fractures per 1 000 km, or per 625 miles,	2		24.1	11.6	:	14.7	ø,
	5 to 10 y	Length of single track of this class,	ţ.	Miles	128.6	3. 15. 3. 3. 3.	. 31	507.0	crossing
		Xumber of fractures.	10		ರ		:	12	and
	than 5 years.	Mumber of fractures per 1 000 km, or per 625 miles,	4		:	8.8	:	4.	g points
	Less than	Length of single track of this class,	£.	Miles.	80.8	445.5	16.6	543.1	excluding
	۲	Number of fractures.	£		:	83	-	60	ies,
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	_	Eastern Railway.	Light ralls: of a weight less than 42.5 kgr. per metre or 85 lb, per yard.	Medium ratis: of 42.5 to 52.5 kgr. per metre (%5 to 105 lb. per yard).	Heavy rails; of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.	Total	(*) Fractures in main lines, excluding points and crossings.

ber of fractures per 10 000 000 train-kilometres or 0 000 train-miles : 84.91.

Number of train-miles: 36 225 734, Total number of fractures; 495.

Percentage: Clear of the fishplates, 83.4 20.0 (1)	Heavy		None (1)			9 pieces.	- i.i
	n.	نب				6 pieces.	: :
sils	Medium.	Per cent. 14.2 33.5	13.3	. 23.1		4 pieces.	4 4
A Fractures of light rails - medium heavy	Light.	Per cent. 21.9 39.8	20.1	က္		3 pieces	17
A. – Fr		 urk .	• •	:		2 pieces.	308
Percentage; Covered by the fishplates. 16.6 80.0 (1)		with silvery oval mark . without silvery oval mark	in the foot. in the head	in the web	oken at the joint,		light medium heavy.
A Fractures of light rails \		a) Fresh and clean fracture in the Whole of the rail section.	b) Fructure, part of which is old and n.uch rusted, extending to the outer surface of the foot or the head of the rail.	c. Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail	(1) Only one 55 kgr. (110.87 1b, per yard) rail broken at the joint,		d) number of pieces into which the rail is broken.
4		В. –			(1) Ou		

	DD01 21	wo unuqxvN		lish is.	۲.	17.	17.7	:	
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		-	English tons.	17.7	17.7	17.	:	
	20 years.	Number of fractures per 1 000 km, or per 625 miles,	91		17	# #	÷ ;	17	ilometres
	than	Length of single track of this class.	El.	Miles.	2 103		8 6 6	2 103	00 train-k
	More	Number of fractures.	14		. 2	:	: 1	57	000
	years.	Number of fractures per 1 000 km, or per 625 miles,	13		=		:	u .	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 27.
	15 to 20 y	Length of single track of this class.	12	Miles.	569		0 0	569	er of fractures per 10 250 000 train-miles : 27
		Mumber of fractures.	Ξ		aG .		:	NO.	.ber c
rails:	ears,	Number of fractures per 1 000 km. 1 per 625 miles.	01		:	56	:	16	Numb 6
Age of rails	10 to 15 years.	Length of single track of this class.	23	Miles,	09	. .		153	
4		Number setures.	20		*	177	:	4	
	ears,	Number of fractures per I 000 km, or per 625 miles,	2		:	8	0 0 0	50	,
	5 to 10 years,	Length of single track of this class,	9	Miles.	:	461	*	461	
		Number of fractures.	9		9	19	:	19	
	i years.	Number of fractures per 1 000 km, or per 625 miles,	4		, :	, n	:	@1	
	Less than 5	Length of this class.	8	Miles.	4	402	0 0 0	406	
	- Le	Yumber of tractures.	87			7	: 1	-	98:
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	→	Midi Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Heavy rails: of a weight equal to or greater than 53 kgr, per metre or 106 lb. per yard.	Total	(*) Main lines. Number of train-miles: 20 009 083. Total number of fractures: 86.

Percentage: Clear of the fishplates, 66 4	Неаву.		None,			18 pieces.	7 ! !
Percel Olee fis.	Н		Z .			11 pieces.	- i i
	Medium.	Per cent. 4.2 4.2	37.5 29.1	25.0		9 pieces.	: : 1
rails	M	- 				6 pieces.	e e . ;
A Fractures of light rails - medium heavy	Light.	Per cent. 14.5 22.6	14.5	24.2		4 pieces.	φ 81 :
A Fracti		Ğ				3 pieces.	o ev :
> 10		l mark val mark .		•		2 pieces.	000
Percentage: Covered by the fishplates 34 96		with silvery oval mark , without silvery oval mark	in the foot, in the head		1.2		light medium heavy
: : :			~				
A. — Fractures of light rails		a) Fresh and clean fracture in the whole of the rail section.	Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail.	Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail			Number of pieces into which the rail is broken
A Fra		- α) F ₁	b) F	ହି			a) N
		B					

		pv01 91:	ov munitary	17	English tons.	85. 76.	%. %.	18.5	:	
	•	20 years.	Number of fractures per 1 000 km, or per 625 miles.	lò		4 to 6 to	23.7	0 .	49.6	-
		than	Length of the class.	15	Miles.	837.00	890.44	0	1 727.44	-
		More	Number of fractures.	=		104	వే	0	13%	-
		years.	Mumber of fractures per I 000 km, or per 625 miles.	13		18.5	19.0	0	18.9	
		15 to 20)	Length of single track of this class.	12	Miles.	34.18	393.34	0	427.52	
			Number of fractures.	=		⊢	21	0	53	
	rails:	ears,	Number of fractures per 1 000 km. or per 625 miles,	IO		85 26	4.06	0	80 10	
	Age of rails	10 to 15 years.	Length of single track of this class.	32	Miles.	45.36	70 11 80 18	0.050	587.71	
			Number seruitself	00		41	4	0	00	
		10 years.	Number of fractures or per 1 000 km, or per 625 miles.	1-		\$.04 \$0.04	15.5	0	10.2	
		5 to 10 y	Length of single track of this class,	٥	Miles.	307.58	359.78	0.56	667.92	
1			Kumber of fractures.	īG.		613	6	0	Ξ	
		5 years.	Number of fractures or per 625 miles,	4		e	e4 67	0	2,3	
		Less than	Length of single track of this class.	23	Miles	0	540.60	1.80	542.40	
_		- Le	Number of fractures,	2		0	61	0	64	
		NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	-	Northern Railway.	Light rails: of a weight less than 42.5 kgr. per metre. or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre. (85 to 105 lb. per yard).	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.	Total	

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 30.

Number of train-miles: 31 378 333.

Total number of fractures: 172.

Percentage: Clear of the fishplates. 72.0 31.2	Нешпу.		None.			21 pieces.	0 0
Pe the					_	6 pieces.	0
	Medium.	Per cent. 6.5 4.9	27.9 23.0	37.7		5 pieces.	0 0
A Fractures of light rails medium heavy	ut.	ent.	10 04		-	4 pieces.	1 8 0
Fractures –	Light.	10.8	31.5	13,5		3 pieces.	00 r 0
		mark	· · · · · · · · · · · · · · · · · · ·			2 pieces.	31 0
Percentage: Covered by the fishplutes. 28.0 68.8		with silvery oval mark . Without silvery oval mark	in the head	in the web	<u> Pa</u>	•	light medium heavy
A. — Fractures of light rails		B_{\star} - a , Fresh and clean fracture in the whole of the rail section	b) Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the rail	c) Fracture part of which is old; and much rusted, not extending to the outer surface of the foot or the head of the rail.			d) Number of pieces into which the rail is broken

load.	olza mumixa M	9 English tons.	ر. 2	18.5	<u>7</u>	:	netres or
Number	fractures per 1000 km. or per 625 miles.	χ	6.4	8.6%	:	÷	N 000 train-kilon
	Lough of single track.	7 Miles,	4 143	2 499	ъ.	:	Number of fractures per 10 (00 000 train-kilometres or 6 250 000 train-miles; 26,
	More than 20 years.	' D		\$ -	* * .	119	Number of fre
٨	15 to 20 years.		4	ent E	:	prod.	
Age of rails:	5 to 10 years. 10 to 20 years, 15 to 20 years.	Ť		:0	i	i~	
	5 to 10 years.	m	:	2	:	ī	
	Less than 5 years.	, D1	ক।	G.	:	=	; 163,
NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS.	Orleans Bailway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (\$5 to 105 lb. per yard).	Henry rails: of a weight equal to or greater than 38 kgr. per m. of 106 to, per yard.	Total	(*) On main lines only. Number of train-miles; 38 797 374. Total number of fractures: 163,

	ŽI.						
Percentage: Clear of the fishplaces. 72. 1 50.0	Heavy.		None.			13 pieces.	7 : :
Per CO						6 pieces.	7 7 :
· · · · · · · · · · · · · · · · · · ·	Medium.	Per cent. 30.0 28.3	7.5	[] ·	A Parameter Control	5 pieces.	: 7 :
Fractures of light rails — nethin . — heavy	ht.	ent.	co co			4 pieces.	` i w i
	Light.	Per cent. 18.6 46.5	2.3	16.3		3 pieces,	en रह :
	-	mark 7al mark .			_'	2 pièces.	88 :
Percentage: Covered by the fishplates, 27.9 50.0		with silvery oval mark . Without silvery oval mark	in the foot. .	in the web	1.		light medium
· · · · · · · · · · · · · · · · · · ·		the {	and the tine	and to or			the ·
A. — Fractures of light rails		Fresh and clean fracture in the whole of the rail section	Fracture, part of which is old and much rusted, extending to the outer surface of the foot or the head of the ruit.	Fracture, part of which is old and much rusted, not extending to the outer surface of the foot or the head of the rail			Number of pieces into which the rail is broken
		B a)	9	(0			q)

Age of rails:	10 years, 10 to 15 years, 15 to 20 years. More than 20 years.	himber of fractures per 1 070 km or for function of fractures of bractures of this class. Aumber of single track per 1 000 km or fractures per 1 000 km or fractures per 1 000 km or per 625 miles, or per 625 miles, or per 625 miles, or per 625 miles. Aumber of fractures per 1 000 km or fractures. Aumber of fractures per 1 000 km or fractures. Aumber of fractures per 1 000 km or fractures. Aumber of fractures. Aumber of fractures. Longth of this class. Longth of this class. Journal of this class.	7 8 9 10 111 12 13 111 15 16 17	Miles. Miles. English	1 192 3.24 9 280 19.32 3th 3.638 50.90	38,53 36 1 0ft 22,86 59 1 190 30,80 2tG 1 441 87,53		32.15 37 1 192 19.28 69 1 480 28.55 506 5 139 61.17	
	5 to 1	Vamber of fractures. Length of single track of this class.	5 6	Miles	67	21 239		21 400	rossings.
	years.	Kumber of fractures per 1 000 km, or per 625 miles,	7	· ·	2.65	7.93	99 99	7.19	nts and co
	Less than 5 years.	Length 1 seed of the control of the class.	22	Miles.	234	783	19	1 036	se in poi
-	Le	YadmuM sources.	27		-	01	61	13	g the
F	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		Paris, Lyons and Mediterranean Railway.	Light rails: of a weight of 42.5 kgr, per m. (e5 1b. per yard).	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb, per yard).	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.	Total,	(*) Broken rails, excluding those in points and crossings.

(4) 16 of these in tunnels on 29.8 miles of single line, that is a proportion of 477.61 per 1 000 km, or 625 miles, the proportion of 38.53 being reduced to 9.77 outside tunnels.

(2) 16 of these in tunnels on 24.2 miles of single line, that is a proportion of 410.35 per 1 000 km, or 625 miles, the proportion of 32.15 being reduced to 8.14 outside tunnels.

PARIS, LYONS AND MEDITERRANEAN RAILWAY.

TABLE 1.

	Fractures covered	d by the fishplates.	Fractures clear of the fishplat		
	Number.	Percentage.	Number.	Percentage.	
Light rails	94	29.33	220	70.07	
Medium —	253	76.90	76	23.10	
Heavy	2	100.00			

Table 2

		Fractures partly old.			
Number.	Percentage.	Number.	Percentage.		
170 453	54.14 46.50	144 176	45.86 53.50 50.00		
	Number.	170 54.14	Number. Percentage. Number. 170 54.14 144 453 46.50 176		

TABLE 3.

			,			Rai	ls bro	ken ir	nto:					
	2 pie	2 pieces.		3 pieces.		4 pieces.		5 pieces.		eces.	7 pieces.		8 and more	
	Number.	Per- centage.	Number.	Per- centage.	Number.	Per- centage.	Number.	Per- centage.	Number.	Per- centage.	Namber.	Per- centage.	Number.	Per- centage.
Light rails	260 250	82.80 75.98		10 50 16.11	11 16	3.51 4.86	7 5	2.22	1	0.32	n	, 0.31	2	0.65
Heavy —		100.00		***		***		~				***		***

TABLE 4.

	Fresh and clean fractures through the whole of the rail section.					ures w tending sur	to the o	Fractures with much rusted old part not extending to the out- er surface of the foot		
	oval n		Without oval mark.		of the foot.		of the head.		or the head.	
	Number.	Per- centage.	Number.	Per- centage.	Number.	Per- centage.	Number.	Per- centage.	Number.	Percentage.
Light rails	27	8.60	143	45.54	52	16.56	29	0.24	63	20.06
Medium	19	5.78	134	40.72	42	12.77	24	7,29	1.10	33 44
Heavy			1	50.00	104		1	50.00	•••	

			1	-				-				
ppoj əjxv unuixnjų		Snglish tons.				6.0		. 17	English tons.	♂. **	or	
20 years	Number of fractures per 1 000 km. or per 625 miles.	121			- 133	ਲ ਲ	ilometres	. J		35.2	lometres	
	of rails: 15 years. More than	Length of this class.	lo	Miles.		9.3	1.1	0 train-k	2	Mules.	123.303	00 train-ki
1		Number of fractures.	7					- 8. - 8	Ŧ		1-	.106
		Number of fractures per 1 000 km. or per 625 miles	13				=		22		:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 174.106
		Length of single track of this class.	21				:	of fracture	2		:	of fracture
		Zumber, it fractures,	=					ber c	Ξ		:	250
rails:		Zumber of fractures per 1 000 km, or per 625 miles.	10				:	Nam	2		:	Num
Age of		Length of single track of this class.	Wiles				12.1		6		:	
	Zumber of fractures.	20				:	_	50		:		
	s than 5 years. 5 to 10 years.	Number of Iractures per 1 000 km. per 1 000 km.	7				÷	_	1-		:	
		Length of single track of this class.	9	Miles.			28.0,	_	9		:	
		Number searches.	10				:				:	•
		Number of fractures per 1 000 km. or per 625 miles.	44				:				:	
		Dength of single track of this class.	20				:		m		:	
	r ess	Number to fractures.	21				:	25 28.	31		:	9 829.
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		Cambrésis Railway.	(Cambrai to Catillon and Denain to Catelet and St-Quentin lines).	Light vails:	per metre or 85 lb, per yard.	Number of train-miles : 263 470 Total number of fractures : 28,	-	Bouches-du-Rhône Departmental Railways and Electric Tramways.	Light rails: of a weight less than 42.5 kgr. per metre or 85 1b, per yard.	Number of train-miles: 249 829. Total number of fractures: 7.

17 English tous.	7.9	English tons.	14.8		17 English tons,	14.3	
16	0		109	metres or	91	24.7	netres or
15 Miles.	88	Miles.	89	Number of fractdres per 10 000 000 train-kilometres or 6 250 000 train-miles: 268.	niles.	924	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 156.
4	0		13	000 0	7	6	000
13	:		:	per 10 00 as: 268.	13	:	per 10 000
13	:		:	nnber of fractures per 10 (6 250 000 train-miles : 268,	123	:	unber of fractures per 10 6 6 250 000 train-miles : 156.
=	: :		:	er of		:	r of 1
. 01	:		:	Numb 6 22	10	:	Numbe 6 22
6	:		:		5	:	
so.	:		:		20	:	
	:		:		F-	:	
. 0	:		:	-	ω	:	
70	•		:		70	;	
4	;		i		4	:	
က	:	Miles.	. w	.2.	m	:	37.2.
₹\ 1			:	277 (6/1		: 357 g
1 Tarn Departmental Bailways	Light rails: of a weight less than 42.5 kgr. per metre, or 85 lb, per yard.	Eastern of Lyons Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles : 277 656. Total number of fractures : 12.	1 Light Railways of the Landes.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 357 972. Total number of fractures: 9.

	prog a	wp uninjævy	17		:	£4	_	7	:	
	20 years.	Number of fractures per I Om km, per 625 miles	16		8	Number of fractures per 15 000 000 train-kilometres or 6 250 000 train-miles : 34.		16	72.00	-
	than	Length Jength track sants sint to	ट	Miles.	27.374	o train-k		15 Miles,	112.5	-
	More	Number of fractures.	14		ಣ	- 00		*	=	-
	20 years.	Number of fractures per 1 000 km, per 1000 km, per 625 miles.	13		53	28 per 10 (miles : 34.		EI .	28.08	
	15 to 20	Length of single track of this class,	12	Miles.	21.410	of fracture 000 train-		Miles.	110.6	ails.
		Number of fractures,	E			1ber 5 250		Ξ	ю —	ren r
rails:	years.	Number of fractures per 1 000 km.	01		:	Num		10	:	is of brok
Age of rails	10 to 15	Length of single track of this class.	6		:			0	:	no record
		Yumber samparatio	SO		:	-	ysten	50	:	sdee
	years,	Number of fractures number 1 ood km. Refire 625 neg to	1-		:		on this s	i-	:	moany k
	5 to 10 y	Length of single track of this class,	9		i.		шкпожп	•	:	7, this Co
		Number 20 Number	ಬ		:		1 JSO	rc	·:	19%
	5 years.	Zumber of fractures per I 000 km, or per 625 miles,	4		:		Broken rails are almost unknown on this system.	4	:	staded in 1926 and 1927, this Company keeps no records of broken rails.
	Less than	Length of thock of this class.	m		:		roken ru	ന	:	s staded
	L	Mumber of fractures.	ە ئ			59 80	22	63	÷	Α8
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		Somain-Anzin- Frontière belge Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of truin-miles: 459 800 Total number of fractures: 4.	Provence Railway.	l Ain Departmental Tramways.	Light rails: of a weight less that 42.5 kgr. per metre or 85 lb. per yard.	United Transport Company for Paris and district

=	d.					
17	English tons,	13.8	8.8		25 55 50 50 50 50	0 °;. 2 and 4
16		10,704	*	etres or		©5
. 15	Miles.	. 697	*	' iin-kilo:n	much rusted, or head of the	xtending
14		21	:		nd m foot or	not e he raii broke
13		1	:	er of fractures per 10 000 (250 000 train-miles : 19.326,	e old a of the 1	portions head of t
12	The state of the s	**	:	tures pe ain-mile	hich ar er face oot	rusted foot or which th
=======================================		:	:	of frac	of whe out a the f	much of the s into
10		:	* *	Number of fractures per 10 000 000 train-kilo:netres or 6 250 000 train-miles : 19,326.	b) Fractures, part of which are old and much rusted, extending to the outer face of the foot or head of the rail: 1. Rusted part in the foot. 2. Rusted part in the head	c) Fractures with much rusted portions not extending to the outer face of the foot or head of the rail d) Number of pieces into which the rail is broken
Ф	Miles,	:	186) Fracture extendrail: rail: 1. Ruste	c) Fractur the or d) Number
00		:	:			
÷-		:	:		41 °/. 59 °.	16 % 34 %
9		:	:		of the	the rail
·C			:		ortions fractu	le of
4		:	. :		ective po	the who
က	,	:	:	208.	the resp.	through
?				: 3 858 res : 1	es in plates tes .	mark mark val m
1	ALGERIA AND TUNIS. Algerian State Railways. Algiers District.	of a weight less than 42.5 kgr. per metre or 85 lb. per yard. Medium rails:	of 42.5 to 52.5 kgr. per metre (35 to 105 lb, per yard).	Number of train-miles: 3 859 208. Total number of fractures: 12,	A. — Percentage of fractures in the respective portions of the rails: 1. Covered by the fishplates 2. Clear of the fishplates B. — Fractures according to the appearance of the fracture:	a) Fresh and clean fracture through the whole of the rail section: 1. With silvery oval mark \. \

			1	= -				
	כנה נטמין	op unuquest	17	English tons.	13.8	:	. M. O	
	20 years.	Tommber 10 fractures of fractures on the fact to a soling 525 rad an	16		13.60	:	ometres o	of the ing to or each fr
	than	Length of single track of this class.	lŝ	Milles.	188		train-kil	I much or head or head or extend the rail;
	More	Mumber of fractures.	14		7	:	0000 .	foot foot
	years.	Number of fractures per 1 (c) kin. per 1 (c) kin.	13		:		Number of fractures per 10 000 000 train-kilometres 6 250 000 train-miles : 16,202,	Fractures, part of which are old and much rusted extending to the outer face of the foot or head of the rail: 1. Rusted part in the foot
	15 to 20 y	Length 10 strack series of this class.	12			:	f fractures	Fractures, part of which extending to the outer farrail: Rusted part in the foot 2. Rusted part in the head rectures with much rusted the outer face of the foot tumber of pieces into which
1		Yannber 10 trees.	Ξ		_ :	:	0.000	par part part part with
rails:	ears.	rodmuX sormort to rud controd solim 880 rod ro	10		:	:	Numb 6 25	Fractures, part extending to truil: 1. Rusted part 2. Rusted part Fractures with the outer face of pieces.
Age of rails	10 to 15 years.	digne.I dosri elanis lo sessio eldi lo	6		:	:		b) Fra 1. 2. 2. Fra 4. Nu
V		redinnal to	20		:	:		
	ears,	Mumber of fractures per I 000 km. or per 625 miles.	7		:	:		25 %, 75 %, 75 %, 25 %, 25 %, 25 %, 25 %,
	5 to 10 years,	Length of single track of this class,	9	Miles,	:	17. 12.		rail
		Zumber seinferi 10	ia		:	: -		ions of the
	5 years.	rodinity seruteral lo and not freq solun 59a req ro	77		:	:		ective port
	Less than 5	dignod Journ olgnis To ,sect) sift To	00	Mules.	1,	7 <u>6</u> 2.	.00	the response of the response o
	Les	Number of tractures.	?₹		:	:	25 · ·	shpla lates, the aj ure (mar
	NAMES	ATTONS OF RAILS	-	Bône District.	I Aght rails: of a weight less than 42.5 kgr. per metre or 85 10. per yard.	Medium vails: of 42.5 to 52.5 kgr. per metre 85 to 105 lb, per yard).	Number of train-miles: 1534 (00), Total number of fractures: 4	A. — Percentage of fractures in the respective portions of the rails: 1. Covered by the fishplates

	pv01 11xv 1	anını x oM.	6 English tons,	10.38	S or	0 % 0
	.S.	Number of fractures per 1 000 km. or per 825 miles	.o	13,65	Number of fractures per 10 000 000 train kilometres or 6 250 600 train-niles ; 65,026,	of the
	More than 20 years.	Length of single track of this class	A Miles	e	mber of fractures per 10 000 6 250 690 train-mites : 65,026,	b) Fractures, part of which are old and much rusted, extending to the outer face of the foot or head of the rail. 1. Rusted part in the foot
Age of rails:	W	Number of fractures	77	æ	Number 6 250	b) Fractures, part of whirting to the outer rail: 1. Rusted part in the for 2 Rusted part in the hc) c) Fractures with much ruthe outer face of the for the outer face of the for the outer face of the for the form.
A S	Less than 5 years	10 to 15 years 10 to 20 years.	71	None.	720 040. : 18.	4. — Percentage of fractures in the respective portions of the rails: 1. Covered by the fishplates. 2. Clear of the fishplates. 3. 6. ". 6 Fractures according to the appearance of the fracture: 7) Fresh and clean fracture through the whole of the rail section: 83.3 ". 1. With silvery oval mark. 2. Without silvery oval mark. 2. Without silvery oval mark.
NAMES	ADMINISTRATIONS AND	DESCRIPTION OF RAILS.	Oran District.	Light radis: of a weight less than 42.5 kgr. per merre or 85 lb, per yard.	Number of train-miles: 1 720 049. Total number of fractures: 18.	4. — Percentage of fractures in the respective 1 1. Covered by the fishplates 2. Clear of the fishplates, B. — Fractures according to the appearance of a) Fresh and clean fracture through the wescion: 83.3 %. 1. With silvery oval mark 2. Without silvery oval mark .

		ף נטמק	wo unaga 1/1	17	English tons.	16.39	16.39	16.39	:	59.	11	English tons.	
		20 years	Zumber of tractures per 1 000 km, or per 625 miles,	16		30	.:	8	30	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 52.94.	16	24.69	3 250 000
		More than	Length of single track seass,	15	Miles.	310.7		:	310.7	0 000 trai	15	Miles.	netres or
1		Mo	Yannber 10 tractures,	7		10	:	:	15	10 OC	14	9	kilon
		20 years.	Zumber of fractures of per 1 000 km.	E			:	# 0 0	10	tures per train-mil	13	:	000 train
1		15 to 20 1	Length 12 design of this class,	12	Miles.	124,3	*	*	124.3	er of frac 6 250 000	12	:	er 10 000 36,
			Xumber to tractures.	=		-	1.	:	_	umb	11	:	ares pout
The state of the s	rails:	years.	. Number of fractures per 1 000 km, or per 625 miles.	01		11.11	:	:	1.11	7	10	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : about 36.
	Age of rails	10 to 15 y	Length of this class.	6	Miles.	111.8	:	*	8.111		6	:	Numbe
			redition X services	SQ.		গ	:	:	63		00	:	
		10 years,	Number of fractures per 1 000 km, or per 625 miles.	1		12.90	•	:	12.90		7	÷	7 940,
		5 to 10 y	Length track of single strack that the strack.	,	Miles.	696.3	5.	:	103.8		9	:	go : 16_107
			Zumber of fractures.	ia		જ ર	:	:	3.5		50	:	arsa
		5 years.	Number of fractures per 1 000 km.	+		:	:	:	:		4	:	орен 29 ус
The state of the s		Less than	Length of single of sign of the single single of the single single of the sign	22	Miles.	100.0	37.9	e	139.1	109.	.63	:	533. Tine was
-			Yumber earntoant to	21				_:_	:	2 347 8 : 2(61		043 se the
		NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	Ponic I conc	and Mediterranean Railway	Light rails: Light less than 42.5 kgr. per metre or 85 1b. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb, per yard.	Total	Number of train-miles: 2 347 109. Total number of fractures: 20.		Galsa Kariway. Light rails: of a weight less than 42 5 kgr. or 85 10, per yard,	Number of train-miles : 1 043 533. Number of train-miles since the line was open 29 years ago : 16 107 940, Total number of fractures : 6.

			1	qs.			_										
	ופ נסמין	xp mumixvM.	17	English tons.		11.8	14.8	11.8	14.8	11.8	14.8	14.8			:	:	
	20 years.	Number of fractures per 1 000 km.	9I I			38.393	544,436	868°48.	4.076	:	124.319	:			:	24,5358	-
ı	than	Length of this class.	15	Miles.		145.66	4.57	364.41	152.44	158.27	29.99	107.51	20.8		:	983.69	l letres or
	More	Xumber setures.	14			6	寸	10		:	9	:				68	kilon
ı	years,	Munber of fractures per 1 000 km, or per 625 miles.	133			*	:	23.872	8.152	;	:	:	*		:	10.107	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 107, 162.
ı	15 to 20)	Length of this class.	12	Miles.		145,66	4.57	364.41	152,41	158.27	29.99	107.51	20.84		:	983.69	per 10 000 es: 107.16
		Number of fractures.	E			:	:	7	67	;	:	:	:		:	91	ures n-mil
rails:	years.	Yamber of fractures net 1 000 km, per 625 miles,	10			:	:	:	:	:	:	i	:		÷	:	r of fract 0 000 trai
Age of	10 to 15 y	Length of single track of this class.	6	Miles.		145.66	4.57	364.41	152.44	158.27	29.99	107.51	20.84		:	983.69	Numbe 6%
J		Number of fractures	20			:	:	:	:	:	:	:	:		:	:	-
ı	10 years,	Number of fractures per 1 000 km or per 625 miles.	-			:	:	:	:	i	: ,	:			:	:	
ı	5 to 10 y	Length of this class.	9	Miles.		145.66	4.57	364.41	152,44	158.27	29,99	107.51	20.84		:	983,69	
		Number of fractures.	i.c			:	: .	:	:	:	:	:	:		:	:	
١	years.	Number of fractures or per 1 000 km, selim 625 req ro	4			:	:	1,705	:	:	:	:	:		:	0.6316	
	Less than 5 years.	Length days the second of the second single class.	n	Miles.		145.66	4.57	364.41	152 44	158.27	29.99	107.51	20.84		:	983.69	7.
	Le	Number serving of fractures.	es.			:	:	~	:	:	:	;	:		:		: 56.
	NAMES or	- ADMINISTRATIONS AND DESCRIPTION OF RAIL'S		Tunisian Railways.	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	20 kgr. (40.32 lb. per yard) (narrow gauge) 25 kgr. (50.40 lb. per yard)	(Standard gauge) 25 kgr. (50.40 lb. per yard)	30 kgr. (60.48 lb. per yard)	(Standard gauge)	(narrow gauge). 34 kgr. (68.54 lb. per yard)	(standard gauge) . 38.20 kgr.(77.9) lb. per yard)	(Standard gauge)	Medium rails: of 42.5 to 52.5 kgr. per m (85 to 105 lb. per yard) 46 kgr. (94.2 l lb per yard) (standard gauge)	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb, ner vard	None.	Total	Number of train-miles; 3 247 177. Total number of fractures; 56.

		50)													
_	Per	not extending	outer surface of the foot	or the head of the rail.	- neored - surf	67								13.05	0	:	12,50	
THE FRACTURES	Fracture, part of which is old and much rusted	not ex	outer of th	or th	Rumber	21								က	0	:	ec	
FRAC	t of wi	outer oot	T.	in head.	Persen-	(i)								21.7:	0	:	20.83	_
	re, par	t the fo	PART	the 1	1-dank	AT.								ro	0	:	7.0	
E OF	Fractu	extending to the outer surface of the foot	RUSTED	the foot.	Por en-	<u>x</u>								65.21	100	:	. v6.67	_
RANCI	-	exte	or or	- All	Je rutay									īā	~	:	16	
APPEARANCE OF	Fresh and elean	whole of the rail section.	A.z.	it silve mark	подніж з Івхо	9								0	С	:	=	
	Fresha	mactur whole rail se	A	silver Ansar	diiw Isvo	22								0	. 0	:	=	~ <u>~</u>
		Clear of the	lates.	·, -n.	Pered (aga	14			,					91.33	100	:	91.06	Number of train-miles : 1 243 398
	FRACTURES	ं रें	fishplates	191	lmuN	9								28	-	:	: ::	niles :
	FRAC	Covered by the	fishplates.		orrod ega)	25								8.60	0	:	8.33	train-1
		Cor	Idsh	er.	quin X	=								. 63	0	:	જ ર	ber of
		0 years.	s n, ses.	mper non kr	nVI ni lo i raq i ray ro	10								39.65	0.70	:	18.60	Z
		More than 20 years.	*s ज्ञृ	२ जुधर बुद्ध मुख्य	quis to	0								360	135	9,	118:	
		Σ		mper.	ny	œ								23		0	37	
	rails:	years.	,11	redmi ermon pl (00) pl (00)	rit to	1-				•				:	÷	:	:	
4	Age of rails	5 to 20 y	ok 5.	ខេត្តពន វ៉ុះទ ស្រ អតិស្រេ	gnis 10	9									:	:	:	
	8			ionites mper	υN	,0								:	:	:	:	-
		years.	*10	190m 9miter 14 000 im 3%	nd - nd lo frag ragro	-								÷	:	ŧ	:	
		Less than 5 years.	240 **	8819-8 11841 11841	ə.I şaiz 10 . id) 10									:	:	:	:	th fous
_		ĭ	*5	icintes mpet	n N m lo ,	21								*	:	į	:	- Enolis
		NAMES	ADMINISTRATIONS	AND	DESCRIPTION OF RAILS	-	COLONIES	AND	PROTECTORATES.	AFRICA.	French West African	Railways.	a) Thiès to the Niger.	Flat, 20 kgr. (40.32 lb. per yard), 6 m. (19 ft. 8 1/4 in.) long.	Flat, 25 kgr. (50.40 lb. per yard), 8 m. (26 ft. 3 in.) long.	Flat, 26 kgr. (52,41 lb. per yard).	Total,	Maximum ayle load · 9 S English tous

Maximum axle load : 9.8 English tous

Number of train-miles: 1 243 338, Number of train-miles: 119.93, Number of fractures per 10 000 000 train-miles: 119.93,

			1-	48						
	ppoq əq	xv unuixnp	17	English tons. 9.8	or			17 English tons.	5.9	F
	20 years.	Number of fractures per 1 000 km.	16	:	lometres			J6	511	ometres o
	than	Length of single track of this class,	5	i	 train-ki			15 Miles.	21.7	train-kib
	More	Number of fractures.	4	:	- 00 1			14	81	0 000
	years,	Number of fractures per 1 000 km. or per 625 miles.	13	:	Number of fractures per 10 000 000 train-kilometres or 0 250 000 train-miles: 18.44.			13	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 17.30.
	15 to 20	Length task to single track to single that	120	:	f fracture 00 train-n	pe		63	:	f fractures Oottrain-n
		Zumber Zumber 10	=	:	ber o			Ξ	:	250 0
rails:	years.	Mumber of fractures per 1 000 km, ml per 625 miles.	2	8.33	Num o			0	:	Num 6
Age of rails	10 to 15 y	Length of this class.	D.	70.	-			6	:	
		Number satures	S	prod	mus.			20	:	
	10 years,	Number of fractures per 1 000 km or per 625 miles.	7	:	-			<i>(~</i>	:	
	5 to 10 y	Length of this class.	:0	÷		7.	7.	9	· .	
		Number of fractures.	ric .	:	-	n 192	n 192	10	;	
	years.	ToumNer to fractures of fractures of tractures, mix 000 km, to fracture of the	Ŧ	:	i.	No fractured rails in 1927.	No fractured rails in 1927		* * * *	
	ss than 5	Length frack of track of the class.	80	•	້	No fractui	fo fractur	e0	;	
	Less	Number of fractures.	63	:	27 96 : 1.	<i>A</i>		65	:	16 300 : 18,
	NAM ES OF	ADMINISTRATIONS AND AND DESCRIPTION OF RAILS	b Conakry to the Niger Beilmon	25 kgr. per m. (50.40 lb.	Number of train-miles: 327 965. Total number of fractures: 1.	c) Dahomey Railways.	French Dahomey Railway Company.	Reunion Island Railway.	42.5 kgr.	Number of train-miles : 646 300. Total number of fractures : 18.

	4	or per 625 nules.	12	English tons.	12,48 12.99		:	yard).	17	English tous.	14.27	es or	17	English tons.	Ø. 00	es or
	20 years	Number of fractures per 1 000 km.	16		20.8	8 0%	10 000 000 train-kilometres 85.8.	lb, per ya	91	-		kilometre	16		· m) 000 train-kilometres
	e than	Length 10 Kerst 10 Length 11 Reserved 11 10	15	Miles.	91,22	997 94	(O train-	(60.48	15	Miles.	25 000	00 train-	15	Miles.	371.0	0 train-1
	More	Yamber 10	+1		7.E	2	0000	kgr.	14		* :	000	14		(2)	
	years.	Toumber 10 miles; my 100 km; 100 km; 196 rot 100 lot 196 rot 100 lot 1	I3		:		Sep **	p line, 30	13		÷	fractures per 10 000 000 train-kilometres) train-miles : 0.	13 ·		•	s per 10 miles: 9
	15 to 20 y	Length 10 Length 10 sack 10 sack 10 lange 10 lan	12		:		of fractures pe	Standard gauge ; Rayak-Halep line,	12	Miles.		of fractures per	12	Miles.	63,4	mber of fractures per 10 000 6 250 000 train-miles : 9.
		Number series.	=		:		Number 6 250 (: 18c	Ξ		:	Number of 250 000	Ξ		0	Number of 6 250 00
rails:	years,	sormber 10 mil of tractures and contracting per first mil contraction from the contraction of the contractio	10		:		MM O	urd gauge	10		:	Nur	10		च्यं	Num
Age of 1	10 to 15 y	Length 10 density of this class.	6		:	-		(2) Stande	0	Miles.	127		6	Miles,	11.5	
V		reduning seruterit to	00		:	Ī		-	00		:		20		(1)	į,
The second	ars.	Mumber of fractures per 1 000 km. or per 625 miles.	7		:			per yard).	7		:	•	-1		:	
	5 to 10 years.	Length of single track of this dass,	9		:		s and	(55.68 lb.	9		•		9		* * * * * * * * * * * * * * * * * * *	
		YadmuZ seruther 10	5		:	Ī	509 057. 766. breakages	kgr.	7.0		:		70		:	
	years.	Number of fractures per 1 000 km, or per 625 miles,	4		:		nas : 509 057. : 189 766. : new breaka	line, 27.620 kgr.	4		:		4		:	
	s than 5	Length of singele track of this class.	20		:		outh-Dan ik-Halep f which 3	Damas li	60	Miles.	33		3		*	.6.
	Less	Number of fractures.	*>		:		Beyr Rays	routh-	87		:	19.237	87		:	954 806. : 3.
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	I .	Damas-Hamah and Extensions Railway.	Light rails: of a weight less than 42.5 kgr. per mere or 85 1b. per yard.	Total	Number of train-miles: Beyrouth-Damas: Protal number of fractures: 10 of which 3 new 7 with old rusted part.	(1) Narrow gauge : Beyrouth-Damas	1	Smyrne-Cassaba and Extension Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard,	Number of train-miles; 549.237. Total number of fractures: 0.	INDO-CHINA.	Indo-Chinese Colonial Railways.	Light rails; of a weight less than 42.5 kgr. per metre or 85 ib, per yard,	Number of train-miles: 1 954 Total number of fractures: 3

Fresh single dean fracture in the Whole of 6 the rail section without stillers over an mark. — (2) Fresh and clean fracture in the whole of the rail

=	- E				<u> </u>						
17	English tons.	8.6	or .	17	English tons.	14	28	or any's		extending	outer %
16		*	lometres cracks,	16		:		lometres is Comp			to the or $3 = 9.4$ ption of t
ls.		:	train-ki res; 220	15				train-ki gs) in th		ch ruste	extending 28.1%. broken: pieces:
14		:)00 000 fractu	14) 000 000 sidin		d muc the ra 3.1 %	was was was mplete
13		16 broken. 62 cracked.	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 57 fractures; 220 cracks.	13		:	:	in-miles: 63 899 16i. O'umber of fractures per 10 000 000 train-kilometres or fractures; 32. 6 250 000 train-miles: 3.13. tatement, shews, the number of rail breakages which occurred in main running lines (as distinct from sidings) in this Company's for completing the columns headed "Length of single track" of each weight and age of rail are available.		Fractures, part of which are old and much rusted, to the outer face of the foot or head of the rail: 1. Rusted part in the foot: 1 = 3.1%. 2. Rusted mart in the head of the foot of the foot.	B) – Percentage of fractures according to the appearance of the fracture: a) Fresh and clean through the whole of the rail section: 6 = 18.8 % 1. With silvery oval mark: 1 = 3.1 % 2. Without silvery oval mark: 5 = 15.7 % Note. — Compiled on full section rails of points are not included. 2. Fractures with much rusted portions not extending to the outer face of the foot or head of the rail and section is section. So in the fracture of pieces into which the rail was broken: 2. Pieces: 25 = 78.1 %: 3 pieces: 3 = 12.5 %: 4 pieces: 3 = 9.4 %: Ande. — Compiled on full section rails of points are not included.
12	Miles.	534	f fracture	12		:	:	f fracture train mil (as dist		which are the foot	ch rusted or head of nto which 3 pieces :
II		A broken.	nber o	- [f		4	aber of	Š	part of r face o ed par	th mue e foot o leces i leces i .1 %.
10		÷	Nun	10		:	:	Number of train-miles: 63 599 16i. Number of train-miles: 63 599 16i. Number of fractures: 22. The above statement shews the number of rail breakages which occurred in main running lines tem. No statistics for completing the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of single track" of each weight and age of recompleting the columns headed "Length of the columns" of the co	FRACTURES	ctures, I the outer	stures wi ace of the aber of pi 25 = 78
6		:	-	6.		:	:	main ch wei	FRA	b) Fra	c) Fracture face d) Number 2 pieces: 25 a complete br
<u>~</u>				x		<u> </u>		red in	THE		2 pi
2-		:	•	-				occur	OF T		led to
		· 				: 	:	which ingle t		red by	cture: 18.8 %
9		:		9		:	:	kages .	PARTICULARS	ls cove	the fra n:6=] is co
Tio.		:	racked	10		:	ic	il b rea " Leni	RTIC	s of rai	ance of section % fractur fractur of poin
4		:	m; 53 c	4		:	:	of ra	PA	portion	appear the rail = 3.1 % = 15.7 aly. A
~		:	s broke	es			 i	number lumns		= 53.1 %	to the hole of k; 1 = rk; 5 r
- GY			4 867. 14 rail			·		9 16i.		n resp ces: s: 17 = 15 = 4	cording the wal marl wal marl marl marl marl marl marl marl ma
_		.: .:	: 1 74 tres :	ं	_· >.			63 89 res: 3 shew leting		tages i ishpla hplate ates :	res ace hrough ry over very o full s crossi
Yunnan	رة ن ن	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 1744 867. Total number of fractures: 14 rails broken; 53 cracked		ELAND. Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Meanum rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard). jk	Number of train-miles: 63 899 16; Total number of fractures: 32. The above statement shews (the tem.		 Percentage of breakages in respective portions of rails covered by and clear of the fishplates: Covered by fishplates: 17 = 53.1 ° Clear of fishplates: 15 = 46.9 ° 	 B) - Perceptage of fractures according to the appearance of the fracture: a) Fresh and clean through the whole of the rail section: 6 = 18.8 % l. With silvery oval mark: 1 = 3.1 % 2. Without silvery oval mark: 5 = 15.7 % Note Compiled on full section rails only. A fracture is considered to a fracture of crossings and stock rails of points are not incompleted. Wing rails of crossings and stock rails of points are not incompleted.
	Railways.	it less that per metre i lb. per y	r of tra	- 4	BKI AND F IRE	Light rails: weight less than 42.5 per metre or 85 lb. per yard.	Medium rails: to 52.5 kgr. per to 105 lb. per yai	of tra imber ove st istics f		cover Clear	entage resh an 1. Wi 2. Wi Wing
ndo-China &	Ra Ligl	weight less that per metr or 85 lb. per	Number Potal m	E	GREAT BR AND NORTH OF IR Great Western	Light le	Medin 5 to 52. to 105	Number of tra Total number The above s tem.		- Percan	a) Fi
pu		of a w	AF	Ş	NOR Grea	of a we	of 42.	Num Tota The System. No		A	B; top*

	פופ נוסמק	vv unuixvK	12	English tons.		:	20.9	or
	20 years.	Number of fractures per I 000 km. or per 625 miles.	16			:	2,14	ilometres
	More than	Length of single track lot this class.	15	Miles.		1 222	4 971	% train-k
	Mor	Number of fractures.	1			:	1	. 86 . 86 . 90
	rears.	Number of fractures per 1 000 km. or per 625 miles.	13			:	4.17	Number of fractures per 10 000 000 train-kilometres or 6 280 000 train-miles : 1.93.
	15 to 20 years.	Length of track to lass.	12	Miles.		:	1 946	of fractur 0 000 train luded.
		Number of fractures.	=			:	13	nber 6 250
rails:	ears,	Number of fractures of tractures of tractures of tractures of per 625	10			ig 6 0	4.64	Nun idings not
Age of rails	10 to 15 years,	Léngth of single track seals single	6	Miles.		•	1 480	turn — S
		Mumber of fractures	20			:	7	al re
	ears,	Number of fractures per 1 000 km. or per 625 miles.	7-			*	1.47	n statistic
	5 to 10 years,	Length of single track of this class.	9	Miles.		*	1 701	a k en fron lines.
		Number of fractures.	ıc.			:	41	iles t
	years.	Number of fractures or per 625 miles, or	4			:	0.31	: 13 360 m
	Less than 6 years.	Length track of this forth elast, of the single chast,	3	Miles.		,	2 040	2 605. 5. gle track include t
	ا د	Muniber of fractures.	2			:		8 : 46 sing
	NAMES	ADMINISTRATIONS . AND DESCRIPTION OF RAILS		London Midland and	Scottish Railway.	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Number of train-miles: 149-102-605. Total number of fractures: 46. Running lines reduced to single track: 13-360 miles taken from statistical return — Sidings not included The total of fractures does not include those on goods lines.

PARTICULARS OF THE FRACTURES.

a) Fresh and clean fracture through the whole of the rail section: 29-63%;;

Fractures part of which are old and much rusted extending b) Fractures part of which are old and much rusted extending A. — Percentage of breakages in respective portions of the rails covered by and clear of fishplates.

Clear of fishplates: 30-65.2%. — Covered by fishplates: 16-34.8%. Percentage of fractures according to the appearance of the fracture. B.

to the outer face of the foot or head of the rail, 1. Rusted part in the foot: 9=19.5 %; 2. Rusted part in the head; 7=15.2 %.

c) Fructures with much rusted portions not extending to the outer face of the foot or head of the rail: 1 = 2 %. d) The number of pieces into which the rail is Four cases both foot and head,

The above is compiled on full section rails only. A fracture is considered to be an entire separation from top to bottom (or a complete interruption of the top flange).

Cranked or bent rails are not included when broken at the bend. Wing rails of crossings are included when the fracture is not at the bend. Side or stock rails of points are included.

. :	us.									
2	English tons.	%	22.5	:		English	tons.	22.5	:	92
. 25	2	1.85	3.06	2.59	lometres the runn	16	2.26	2.69	2.53	ilometre
	Miles.	1 692,90	2 655.05	4 347.95) train-ki	I5	1 658.80	2 784.73	4 443.53	10 train-k
. 4	H	υ.	13	1 20	- 100 000	14	6	12 2	181	. 000 .61.
52		:	3.47	3.18	s per 10 (les : 4.09	13	:	4.34	3.98	s per 10 miles: 2
12	Miles.	132.06	1 442.45	1 574.51	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 4.09. the head is broken away leaving a gap in the running	12 Miles.	130.97	1 438.30	1 569.27	Number of fractures per 10 000 000 train-kilometres 6 250 000 train-miles : 2,61
=		:	œ	00	Ther of 250 00 head i	Ξ	:	10	10	mber 6 250
10		:	3.91	3.68	Nun 6 e of the 3	10	:	2.52	2.37	Na
6	Miles.	99.57	1 597.30	10 1 696.87	en a piec	9 Miles.	98.48	1 482.82	1 581.30	
. 00		:	10	10	so wh	∞ .	:	9	9	
I-		:	7.29	7.01	m ; b) als	1-		3.54	3.40	an-mark
9	Miles.	40.84	1 029.46	1 070.30	p to botto	6 Miles.	40.84	1 060.33	1 101.17	
70		:	12	12	om to	- io	:	. 9	9	ŧ
4	•	:	3.22	3.16	vered fr	4.	:	1.41	1.37	
m	Miles.	38.96	1 741.74	1 780.70	1926.	Miles.	38.97	1 776.59	1 815.66	791.
			6 1	6	year 86 999 8: 57 1) com ails in	63	:	4	4	5 177
prod.	London and North Eastern Railway. (*)	Light rails: of a weight less than 42.5 kgr. or 85 lb, per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total,	(*) In running lines, year 1926. Number of tractures per 10 000 train-kilometres or factures; 57. Rails are broken when: a) completely severed from top to bottom; b) also when a piece of the head is broken away leaving a gap in the running surface. — Broken rails in sidings not included.	Loudon and North	LAGNETH RAILWAY. Light rails; of 5 Weight less than 42.5 kgr. or 85 lb. per yard.	Medium rails: of 2.5% 52.5 kgr. per metre (85 to 105 Ip. per yard).	Total,	Number of train-miles: 105 177 791. Total number of fractures; 44.

	נוף ניסמין	ev munixoK	17	English tons.	:	20.65] :	10			or-
	20 years.	Number of fractures per 1 000 km, or per 625 miles.	16		42,892	2.593	8.428	per 10 000 000 train-kilometres les : 5.804.			, rusted p
	than	Length of this class. of this class.	15	Miles.	304	1.205	1.409	00 train-k			val mark
	More	Number of fractures.	14		4	ಬ	19	000 0			ery o
	years.	Number of fractures per 1 000 km, or per 625 miles,	13		54.348	4.601	5.967	er of fractures per 10 000 250 000 train-miles : 5.804			thout silv
	15 to 20 y	Length of single track of this class,	12	Miles.	23	815	838	of fractures 000 train-mi	plates:		th and wi
		Number of Iractures.	=		83	9	So	Number of 6 250 00	e fist		»;
rails:	years.	Number of fractures per 1 000 km. or per 625 miles.	10		*,	14.205	14.205	an N	lear of th	9.00	acture i, e
Age of rails	10 to 15 y	rength of single track of this class.	6	Miles.	ŧ,	352	352		by and eles: 16 =	3	of the fr
		Number estures	20		:	οc	200		ered hplat	38.	ипсе
	sars.	Number of fractures per I 000 km, or per 625 miles,	7		:	8.17	8.17		portions of the rails covered by and clear of the Breakages covered by flahplates: 16 = 31,37 % of the perspectation of characters of the second seco	2 pieces 3	he appear return.
	5 to 10 years.	Length of single track of this class,	9		*	765	765		ns of the		tures according to the appe be kept for the 1928 return
		Number of fractures.	55		:	10	101		portions o Breakages	bro	areon pt fo
	years.	Number of fractures per 1 000 km, or per 625 miles,	4		:	4.814	4.814		Spective B	the rail is	fractures Will be ke
	Less than 5	Length of single track of this class.	က	Miles.	:	779	977	625.	in the re	to which	1927, but
	Le	Number of fractures.	25		:	9	9	4 915 3 : 51.	kages	es in	perce for 1
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	1	Southern Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 10, per yard).	Total	Number of train-miles: 54 918 Total number of fractures: 51	A.— Percentage of breakages in the respective portions of the rails covered by and clear of the fishplates Breakages covered by fishplates: 16 = 31.37 %. Breakages clear of the respective of	B_* — The number of pieces into which the rail is broken	Information in regard to percentage of fractures according to the appearance of the fracture i.e. with and without silvery oval mark, rusted portions, etc., is not available for 1927, but will be kept for the 1928 return.

No broken rails in 1927.

Cheshire Lines Committee.

=					
17	西立 2	s or	44 44 n,0 Nil.	17 English tons.	50
- 16	34,44	 cilo metr es		90	:
15	Miles.	00 train-è	r much or head t extend rail.	Miles.	14.050
14	6	1 000 (.772.	f and foot	4	:
133	:	es per 10 miles : 14	are old the ol	13	:
12	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 14,772.	of which couter far the foot the head (Ich ruste foot the foot into white fail into white fail into white	12 Miles.	3.650
Ξ	:	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	art to the art in art in the bridge of see of see, l.	1	_
01	:	Num 6	b) Fractures, part of which are old and much rusted, extending to the outer face of the foot or head of the rails. 1. Rusted part in the foot. 2. Rusted part in the head. 5) Fractures with much rusted portions not extending to the outer face of the foot or head of the rail. d) Number of pieces into which the rail is broken: 8 rails into 2 pieces, 1 rail into 3 pieces.	00	:
6 -	:		b) Fra e: r. r. 1. 2. 2. c) Fra d) Nuu	Miles.	20 20 20 20 20 20 20 20 20 20 20 20 20 2
co	:	-		0	:
-	:		ails: 44.44 % 55.56 % 44.44 % 7.	1-	:
9	:		the rails: 55.	Miles Miles	000.
10	:		ons of	ro	-
4	:		tive portic	41	i .
ec	:	.183	he respectates. appearanted hrough the k	Miles.	669.
63		807 (ishplates of the ture the toward over the cover ove	ev	5 125
	Great Northern Railway (Ireland). (*) Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	(*) In passenger lines. Number of train-miles: 3 807 681. Total number of fractures: 9.	A. — Percentage of breakages in the respective portions of the rails: 1. Covered by the fishplates 2. Clear of the fishplates 55.5 B. — Percentage according to the appearance of the fracture: a) Fresh and clean fracture through the whole of the rail 1. With silvery oval mark 2. Without silvery oval mark	Metropolitan Railway (London.) Medium rails: of 42.5 to 52.5 kgr. per metre	(85 to 105 lb. per yard). Number of train-miles: 5 125 699. Total number of fractures: 3.

	p ⊪01 910	ov uninganfe	17 English tons.	82.11 : 08.11 :	Met. Dist. Tube Rys					
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	16			:	i o			
	than	Length of single track of this class.	£			:	lometres			
	More	Number of fractures.	491			:	ain-k		2.72	
	years.	Number of fractures per 1 000 km, or per 625 miles,	<u>e</u>			29.84	000 000 tr		District.	
	15 to 20 y	Length 10 track single track of this class.	Miles.			104.70	Number of fractures per 10 000 000 train-kilometres or	niles :	Metropolitan District . 2.72. Fube Railways : 2.88.	
		Mumber fractures.	=			73 E	actur	rain-r	Me Tu	
rails:	years.	Number of fractures per 1 000 km. or per 625 miles.	10			:	n nber of fi	6 250 000 train-miles		
Age of rails	10 to 15 y	Length of single track of this class.	9 Miles.			:	N.	9		
		redum Z - santasti 10	α·			:	_			
	10 years,	Yumber of fractures per 1 000 km. or per 625 miles.	1-			÷				
	5 to 10 y	Length of this class.	c	,		:	.000	13 000 000.		s in 1927.
		Leading A tractures.	10			:	- 09	13 000	: is	l rail
	years.	Number of fractures per 1 000 km, or per 625 miles.	TT		22.93 District.)	5.96 ways.)	District :	ys:	Metropolitan Distric Tube Railways : 6.	No case of fractured ralis in 1927.
	ss than 5	Length of single track of this class,	3 Miles.		2 54.50 22.93 Metropolitan District	1) 104.70 5.9 (Tube Railways.)	ning. ropolitan	Tube Railways	Metropoli Tube Rai	fo case of
	Less	Number, estures,	٠١		(Meti)		bur	Tub	es:	Z
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	I Underground Electric Railways Company	of London Metropolitan District and Tube Railways).	Medium rails: of 42.5 to 52.5 kgr. per metre	(85 lb. per yard).	(1) Due to electrical burning. Number of train-miles: Metropolitan District: 4 600 000.	1	Total number of fractures; Metropolitan District: 2. — Tube Railways: 6.	County Donegal Railways Joint Committee.

				— 987 —	- Americana						
English tons.	92	es ning	17	English tons.	17.5	SA do	50		e e		
	:	kilometr the run	91		88	kilometro	extendin		ing to th		
	:) 000 train 30 a gap in	15	Miles.	323	300 train-	rusted,		t extend	roken	
	:	0 000 s:8.8	14	FI	01	. 39.	mucl ad of	%.	ns no ne rai	il is leeces.	
	16.95	ures per l train-mile away lea	13		:	res per 10 rain-miles	re old and	foot : 10 head : 10	ed portion	ich the ra % in 3 pi	
Miles.	36.96	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 8.80 te head is broken away leaving a gap in the runnin	13		:	Number of fractures per 10 000 0.0 train-kilometres or 6 250 000 train-miles: 39.	h) Fractures, part of which are old and much rusted, extending to the outer face of the foot or head of the rail :	10 Rusted part in the foot: 10^{0} / $_{0}$. 20 Rusted part in the head: 10^{0} / $_{0}$.	c) Fractures with much rusted portions not extending to the outer face of the foot or head of the rail : $60~\theta/\eta_0$.	Number of pieces into which the rail is broken $80~0\%$ in 2 pieces, and $20~0\%$ in 3 pieces.	
	prod	umbe	11		:	fumbe or 6	part o	sted p	with r	piece	
	4	N N	10		:	4	ractures,	10 Ru 20 Ru	ractures outer face	fumber of 80 °/ _e in 2	
	:	hen a pie	6		:		(b) F		C) F	a) N	
	:	also w	∞		:						
	:	tom : b) : b	4		:		red .	the	the		
	:	op to bot is in sidi	9		:		ulls cove	rance of	hole of		
	:	rom t	70		:		the r	appea	the v		19 ui
	:	severed f	41		:		ortion of	g to the	through	1/0	No fractured rails in 1927.
	· :	letely surface	3		:		n the p	cordin	eture	, 0% : 3	fractu
	:	0 028.	<u>e</u> 2		i	304 837 : 10.	ages i 80 %	ires ac	an fra	l marl	Z
		s: 7] tures	-	À s ri		s:16	break ates :	fractu	nd cle	у ота	
Great Central and Midland Joint Committee. (*)	Medium rails: of 42.5 to 52.5 kgr. per netre (35 to 105 lb. per yard).	(*) In running lines. Number of tractures per 10 000 000 train-kilometres. Total number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 8.80 Rails are broken when a piece of the head is broken away leaving a gap in the running surface. — Broken rails in sidings not included.	joong	London Midland and Scottish Railway (Northern Counties Committee), Ireland.	Light rails: of a weight less than 42.5 kgr. per metre or 85 1b, per yard.	Number of train-miles: 1 604 837, Total number of fractures: 10.	A. — Percentage of breakages in the portion of the rails covered by the fishplates : 80 9_0 .	B_{\star} - Percentage of fractures according to the appearance of the fracture:	 g) Fresh and clean fracture through the whole of the rail section: 	Without silvery oval mark: 20 %	Midland and Great Northern Railways Joint Committee.

NAMES					N	UMBEI	R OF	FR	ACTUI	RES A	AND	PART	LICUL	AR	S OF T
OF								AG	E OF F	RAILS	:				
ADMINISTRA- TIONS	SECTION	Les	ss than 5	years.		5 to 10 y	ears.	1	0 to 15 y	ears.	1	5 to 20	years.	M	ore than 20
AND	OF	es.		res.	es.		res .	es.		les .	es.		l s	es.	
DESCRIPTION	LINE.	raetui	th track dass.	of fracture 1 000 km. 625 miles.	ractur	th track lass	fractu km.	ruetur	th track lass.	ractur km. miles	ractur	th track ass.	ractur km.	raetur	track ass.
OF RAILS.		er of f	Length f single track of this class,	Number of fractures per 1 000 km, or per 625 miles.	Number of fractures.	Length of single track of this class	r 1 (0)	Number of fractures.	Length of single track of this class.	Number of fractures, per 1 000 km. or per 625 miles.	er of f	Length of single track of this class.	Number of fractures per 1 000 km.	er of fi	Length of single track of this class.
		Number of fractures.	Jo o	Num Pe	Numb	10	Number of fractures per 1 (00) km. or per 625 miles.	Numb	jo	Numb pe or p	Number of fractures.	of g	Numb pe	Number of fractures.	of s
1	2	3	4 Miles.	5	6	7	8	9	10	11	12	13	14	15	
INDIA, DOMINIONS, PROTECTORATES AND COLONIES.			nines.												
AFRICA. Beira and Mashona- land and Rhodesia Railways.															
	Beira-Villa Machado		•••												61
	Villa Machado-Umtali		48 3/4											1	94 1/2
	Umtali-Salisbury													1	170
	Salisbury-Bulawayo													19	295 3/4
	Bulawayo-Livingstone					80			•••					16	206 3 1
	Livingstone-Broken-Hill.		•••											2()	368
Light rails:	Broken Hill-C. Border			sed.							ΰ	132	· pe		
weighing under 85 lb. per yard.	Selukwe Branch	1	23 1/4	t expressed				•••					expressed.		
	West Nicholson Branch.			Not									. Not	2	102 3/4
	Lomagundi Branch					•••						3 3/4			78 3/4
·	Blinkwater Branch										•••	123 1/2			
	Mazoe Branch								***		1	73			
	Total,	1	72	1		80					10	332 1/4		59	1377 1/2
	Number of	of tra	in-miles	: 4 062	809.	- Tota	numb	er of	fracture	s : 70.					

RA	ILW	AY.	=	Class	ification accord General Meetin	ing to part ig of the L	II of suggesti ondon Congres	ons adopted at s in 1925.	the				
l	axle load (engines).	of trains	REMARKS.	pective por	A fractures in res- tions of the ruils and clear of the	Perce	entage of fractur appearance of	res according to	the				
	Maximum	Maximu	ADMINIS.	a) Percentage covered by fishplates,	b) Percentage clear of fishiplates,	a) Fresh and clean fracture through whole rail section.	b) Fractures part of which are old and much rusted extending to outer face of foot or head of rust.	c) Fractures with much rusted portions not extending to outer face of foot or head of rail.	d) Number of pieces into which rail is broken.				
	Tons. (22	23	24	25	26	27				
928	9 1	2 30	41, 3/4 miles relaid during										
330	12 1		1927.			•••							
				***	100.00			100.00					
41	13 0			100.00			100.00						
92	13 0	0 35		31.58	68.42	5.26	84.22	10.52	y.				
46	13 0	0 35		50.00	5.00	18.75	68.75	12 50	s onl				
91	13 0	35		30.00	70.00	15.00	85.00		o pari				
33	12 18	35		11.11	89.89	77.78	22 2 2		in two				
27	9 12	2 25	Engines of 13 tons axle load run occasionally on this branch.	100.00			100.00	,	s broken				
77	12 01	30	Engines of 13 tons axle load permitted at speed of 20 miles per hour.		100.00		100.00		Every rail was broken in two parts only.				
8	9 12	35	Engines of 12 tons 18 cwt. axle load permitted at speed of 25 miles per hour.			•••			Ever				
7	12 01	30	Engines of 13 tons axle load permitted at 25 miles per hour.			•••							
→	9 12	30	Engines of 12 tons 18 cwt. axle load permitted at 25 miles per hour.		100.00		140.00						
	•••			37.86	67.14	20.00	72.86	7.14					
		Nu	mber of fractures per 10 000 000	train-kilometres	or 6 250 000 trai	in-miles + not	evnressed						

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles; not expressed.

	pro1 912	xv mumixnN		71	:	r.	17	English tons.	0.9	9.5	12.5	12.5	16.5
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	-	92	11.23	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 32.	16		:	:	2.54	:	:
	than	Length of single track of this class.		15 Miles.	775	0 train-ki	13	Miles.	:	.:	246	:	:
	More	Youmber 10 tractures.		4	4.	36	4		:	:	-	:	:
	years.	Number of fractures per 1 000 km, or per 625 miles.		55	: ,	s per 10 (miles : 32	133		***	60.9	:	:	:
	15 to 20 y	Length of single track of this class.		es.	;	f fracture OO train-	18	Miles.	:	513	:	:	:
		Number of fractures.		Ξ	:	ber o	=		:	TO.	:	:	:
rails:	years.	Number of fractures per 1 000 km or per 625 miles		90	:	Nam	10		9,40	:	:	:	:
Age of rails	10 to 15 y	Length frack sasis class.		ō	:		6	Miles.	133	:	:	:	:
		Number estures.		00	:		00		6/3	:	:	:	:
	years,	Number of fractures per 1 000 km, or per 625 miles.		r-	:		7		:	:	:	:	:
	5 to 10 y	Length of single track of this class.	No cases of broken rails in 1927	9	:		9		:	:	:	:	* :
		Number of Iracintes.	en rai	ro.	:		70		i	:	:	:	:
	5 years.	Mumber of fractures per 1 000 km, or per 625 miles.	of broke	4	3.18		4.		:	:	:	15.48	4." 88. 89.
	Less than 5	Length of single track of this class.	No cases	Miles.	391	ņ	62	Miles.	:	:	:	569	128
	Le	Number of fractures.		31	24	152 99 3 : 16	2		:	:	:	17	-
	NAM ES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	Gold Coast Government Railways.	l Kenya and Uganda Railways and Harbours.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles : 3 152 983. Total number of fractures : 16	1	Nigerian Railway.	30 lb. per yard	45 lb, —	55 lb	60 lb. —	80 lb, —

NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS.	Light rails: of 17.5 to 23 kgr. per metre (35 to 46 1/4 lb. per yard).	Medium rails: of 30 to 30.5 kgr. per metre (60 to 61 lb. per yard).	Heavy rails; of 37.5 to 42.5 kgr. per metre (75 to 85 lb. per yard).
South African Railways and Harbours,			
Age of rails:			
Less than 5 years.		eg Eg	ĸ
5 to 10 years	:		60
10 to 15 years.	63	· · · · · · · · · · · · · · · · · · ·	. 87
15 to 20 years.	prit pri		59
Over 20 years	n n	180	43
Age unknown (marks undecipherable)	. 34	158	j-red prod
Number of fractures	99	306	223
Length of single track (miles)	2)485	5 885	4 065
Number of fractures per 1 000 kilometres or 625 miles,	14.84	32.50	34.29
Maximum axle load (English ton-1	10.5	13.5	10.5
Total miles /	12 435	* *	:
Number of train-males : 47 791 943. Total number of fractures of all classes of rails : 588.	Number of 6 2	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 76.94.	kilometres
NOTR : The above fractures include those occurring in sidings as well as in running tracks.	dings as well as in running trac	ks.	

			_	Æ	
	proj ej	xv unuix1/1	1.	tons. 12.4	
	20 years.	Number of fractures per 1 000 km.	91	15.25	
	than	Length of single track of this class.	15	Miles. 2 164.468 1 115.482	
	More	Number of fractures.	=	(E) (E) 2 (C) 1 (E) 2 (E	1
	years.	Number of fractures per 1 000 km, or per 625 miles.	13	:	:
	15 to 20)	Length of single track of this class.	<u>62</u>		
		Number of Iractures.	=	:	
rails:	15 years.	Mumber of fractures per 1 000 km. or per 625 miles.	10	i i	
Age of rails	10 to 15 y	Length of single track of this class.	6	Miles,	
		Number of fractures.	∞		
	10 years.	Number of fractures per 1 000 km. or per 625 miles.	[
	6 to 10 y	Length of single track of this class.	9	Miles	
		Number of fractures.	(C)	: :	
	years.	Number of fractures per 1 000 km, or per 625 miles,	÷	:	
	ss than 5	Length of this class.	ಣ	Miles.	
	Less	Number of fractures.	3/	:	
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	1	Sudan Government Railways and Steamers. Light rails: per metre or 85 10. per yard.	(4) 50 lb, per yard.

.buo	1 51 x 2 111111111x2W	10 English tons		Ö	14	:	tres or
Number	fractures per 1 000 km, or 625 miles.	5		6	5.4	5	000 train-kilome
Length	running track of this class of rail.	8 Miles.		352.3	381.24	965.9	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 19.
ails :	Total.	7		=		14	Number of frac 6 250 000 tr
Number of fractures according to age of rails:	Over 20 years.	9		Г	o :	10	H
cording to	15 to 20 years.				- :	-	
ractures a	10 to 15	4	-			proof	334.2.
mber of fi	5 to 10 years.	က		:	: "		motors) ; 4 38
Na	0 to 5	હ		:	•	F-1	cluding rails
NAMES OF	ADMINISTRATIONS AND DESCRIPTION OF RAILS.	Asia.	CEYLON. Ceylon Government Railway.	Light rails: 46 1/4 lb. per yard.	72 and 80 lb. per yard. Medium rails: 88 and 90 lb. per yard.	Total.	Number of train-miles (including rails motors) : 4 382 334.2. Total number of fractures : 14.

	ון בן נימק	xv unwixvy	17 .	English tons.			17.25		10
	20 years.	Number of fractures per 1 000 km. per 1 200 km. or per 625 miles.	16			4.04	3.16	3,55	lometres .
	than	Length of single track of this class,	15	Miles.		928.11	1 185.91	9 114.02	0 train-k
	More	Number of fractures.	14			9	9	62	- 00 % - 00 %
	20 years.	Number of fractures per 1 000 km. per 625 mile-	13	٠		ಬ ಕ್ಷ	644.33	9.58	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 16,53.
	15 to 20)	Length of single track of this class.	1 12	Miles.		387.56	& &	391.44	of fracture
		Number of fractures.	=			61	ক	9	. 250
rails:	15 years,	Number of fractures per 1 000 km. per 625 miles.	10			11.24	80.92	17.81	en Z
Age of rails	10 to 15 1	Length of single track of this class.	6	Miles.		222, 17	23.17	245.64	
		Number of fractures.	00			ফ	27	~	-
	years,	Number of fractures per 1 000 km. or per 625 miles.	1			49.04		36.87	
	5 to 10 y	Length of single track least	9	Miles.		38. 83. 83.	13.62	50.85	
		Number of fractures.	20			က	:	es .	
	5 years.	Number of fractures per 1 000 km. or per 625 miles.	4			\$ \$ \$	12.71	17.09	
	Less than 5	Length of thick of this class.	60	Miles.		88 .5.5	207.07	292.61	
	Le	Number of fractures.	87			4.	4	00	3 610
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	and .	INDIA.	Bengal Nagpur Railway (*)	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 1b, per yard.)	Total	(*) Year 1927-1928. Number of train-miles: 13 610 158. Total number of fractures: 36.

17	:	or	17 English tons.	17.5	18.0	:	ra ge
16	10.27	lometres	10	4.66	:	4.66	res ; percen
i5 Miles.	1 460.02) train-k	15 Miles.	504.928	÷	804.928	n-kilome 48. fishplate
41	24	, 000 000 \$4	7	9	:	9	00 trais: 19.
13	:	ss per 10	13	23.33	3.37	2.92	rain-miles
12 Miles.	197.22	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 21,24	Miles.	804.928	1 112.787	9 1 917.715	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 19,48.
11	:	aber c		ಣ	9	6	of fra
10	:	Nur 6	10	0.78	2,25	1.56	Number the rails
9 Miles.	123,28		9 Miles.	804.928	1 112.787	5 1 917.715	rtions of
on	:		œ	p4	4		A po
-	:		t-	. :	1.12	1.12	or the 127:25. respecti
٥	:		Miles,	:	1 112.787	1 112 787	system for cember 19 es in the not avai
٥	:		c.		63	82	tauge 31 De ractur ure is
#	:		4	:	1.68	1.68	broad g 96. r ending tage of f
Miles.	306.14	.6.	Miles:	i i	1 112.787	1 112.787	nole of the 7:8 019 5 g the year rance of
-		062 83	es	:	e	60	he who ar 1927 during to give appea
Bengal and North Western Railway, (*)	~~~	(*) Year 1927-1928. Number of train-miles . 7 062 816. Total number of fractures : 24.	Bombay, Baroda and Central India Railway. (Broad gauge.)	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard. Medium rails:	of 42.5 to 52.5 kgr. per metre (85 to 105 1b, per yard).	Total	Number of tractures per 10 000 000 train-kilometres vear funding 31 December 1927 : 8 019 596. Total number of fractures during the year ending 31 December 1927 : 25. Note. — It is not possible to give percentage of fractures in the respective portions of the rails covered by and clear of the fishplates; percentage of fracture is not available.

							<	Age of rails	ails:							
NAMES	Le	Less than 5 years.	years.		5 to 10 years,	sars,		10 to 15 years.	ears.		15 to 20 years.	ears,	Mor	More than 2	20 years.	pro1 91
ADMINISTRATIONS AND DESCRIPTION OF RAILS	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km, or per 625 miles,	Number of fractures.	Length of single track of this class.	Number of fractures per 1 000 km, r per 625 miles,	Number sorutes	Length of track of this class.	Mumber of fractures per 1 000 km. or per 625 miles,	Xumber of fractures,	Length of this class.	Xumber of fractures per 1 000 km, or per 625 miles,	Number of fractures.	Length of this lost lost lines.	Number of fractures per 1 000 km.	wo unuix 1/1
	672	က	41	ت. ت	9	ţ~	∞	6	10	11	12	13	14	15	91	17
Bombay, Baroda and Central India Railway. Metre (3 ft. 3 \frac{2}{3} in.) gauge system.								,						Miles.		English tons.
Light rails: of a weight of: 41 \$\frac{1}{4}\$ ber yard.	:	*	:	:	:		:	:	:	. :	:	. :	(3)	1 215.94	6.17	00
50 lb. per yard.	:	:	:	:	:	:	:	~ !	:	:	:	:	24	1 331.00	11.27	10
60 lb. per yard.	:		:	:	: 1	:	:	:	:	:	:	:	:	305.69	:	10.5
Total	:	;	Ę	:	:	:	. :	:	:	. :	1 :	:	38	2 852.63	7.84	:
Number of train-miles: 9 625 000. Total number of fractures: 36.	625 0	.00.							Num	ber of	er of fractures per 10 000 000 to	s per 10	000	Number of fractures per 10 000 000 train-kilometres	ilometres	

or 6 250 000 train-miles : 23.38.

(1) All fractures were outside the portion covered by the fishplates.
(2) 4 fractures or 16.7 % were inside the portion covered by the fishplates; the remaining 20 or 83.3 % were outside the fishplates.

Note. - Percentage of fractures according to the appearance of the fracture is not available.

Burma Railway.

This Company, being taken over by the Government with effect from I January 1929, sent no information,

English tons.		17	13.5	:	13.5	16.5	15.5	18.6	16.55		Ė	:			: ;					37	940
#D		:	:	:	:	:	. :	:							: :		Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles ; 15.35.		85 lb.	122.837	there w
		:	:	:	:	:	:	÷					:		: :	_	train-kilo		9.	414	on whiel
63		:	€5	:	14	41	24	Ξ	_		:	:	:		:	_	.35.		82 lb.	1 548.414	ay, and
			:	110	:	:	:	:	:	-		. :	:	-	:	_	s per 10 iles : 15			0	la Railw
	cture).	:		:	:	:	=	:	:	:	:	:	:	;			fracture; 0 train-m		80 lb.	910.760	Peninsu
Age of Fails (from year of month of the	manura	<u>:</u> :	:	· ·	:	:	:	:	:	:	:	:	:	:	:	-	mber of 6 250 00				lian and
10	year or															_	Ñ		75 lb.	620.597	Freat Inc
(from)		-	:	:	:	:	-		: 	-	:	:	:		: :	-)F:		-	on the (
of rails		:	:,,,	:	:	:	:	:	:	:	:	:	:	:	:	-		RAILS OF	69 lb.	747.021	ls in use
Age	5		: "	:	:	:	:	:	:	:	:	2.	. : -	_ ÷		-					n of rai
		:	:	:	:	:	:	:		:	:	:	:	:	:				62 lb.	56,910	ch sectionileage
		: ·	:	÷	:		:	:	:	:	:	:	:	:	:					·	ge of ear
		£	:	:	:	:	*	:	:		:		:	:	:		430		35 lb.	180,304	al mileago give the
		:	:	:	:		:	:	:	:	:	:	:	:	:	1 1927.	: 2:3 204 res : 57.				s the tot
Great Indian Peninsula Railway. (*)				•	•				•	•	:					(*) Year ended 31 March 1927.	Number of train-miles: 23 204 430 Total number of fractures: 57,			cluding	A) The above table shows the total mileage of each section of rails in use on the Great Indian and Peninsula Railway, and on which there were tractures.— B) It is not possible to give the total mileage according to age as no record exists have no sails as the contraction of the
Indian Peni Railway. (*)	Light rails:	yaın .		;		ì		Medium rails :	yard .		•					ended	ber of tr number		1	ailway ii	above ta
reat In Rai	Light 7.0	62 lb.	68 lb.	69 lb.	75 lb;	80 lb.	82 lb.	Med	85 lb. per yard		87 lb.	× 1/2 1D.	90 ID.	o o	100 lb.	*) Year	Num Total			Miles of railway including sidings.	A) The

	ופ ניסמק	wo unuganjy	17	English tons.	- 13. U	16.5	18.5		202	Es.		100 lb.	1 207.727	were
	years.	Number of fractures per 1 000 km.	16		: :	: :	: :			metres o		1	-	h there
	More than 20	Length of this class.	15		: :	: :	: : :	-	::	rain-kilo		86 Ib.	28,014	on whie
	More	Number of fractures.	7	_	: : :	2 2 2	p 60 60		64 :	000 0		-		y and
	ears.	Number of fractures per 1 000 km. or per 625 miles.	13	-	: :	: :	: : :		0 P 0 0 0 V	per 10 00 es : 17.29		85 lb.	122,837	a Railwa
	15 to 20 years	Length of this class.	19	ture)	: :	: :				Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 17.29.		82 lb.	1 548.414	table shows the total mileage of each section of rails in use on the Great Indian Pennsula Railway and on which there were It is not possible to give the total mileage according to age as no record exists, but no rails of the following sections were order for the last 20 years, 50, 63, 67, 75, 80, 85, 86, and 87 in this last ware of unables of 90 is, made now high
		Number of fractures.	=	ınufac	::-		:		::	250 000		20	1.5	ndian sts, bu
rails:	/ears.	Yumber of fractures per 1 000 km. or per 625 miles.	10	r of ma	::	: :	: : :		: :	Num!		80 lb.	910.760	cord exist
Age of rails	10 to 15 years.	Length of this class.	5:	Age of rails (from year of manufacture)	: :	: :	: : :		: :					se on the
		Number of fractures.	x	ails	7		4 TO :		: 0		S OF	75 lb.	6?0.597	s in u to age
	ears,	Number of fractures per 1 000 km. or per 625 miles.	7	ige of r	: :	: :	: : :		::		RAILS			rording
	5 to 10 years,	Length of single track of this class.	9	•	: : :	:	: : :		: :			69 lb.	747.021	h section leage ac
		Number solutions.	0	•	: :	: :	: : :		: 22					of each
	years.	Number of fractures per 1 000 km. or per 625 miles.	7	•	: : :	:	: : : :		::			62 lb,	56.910	mileage ive the to
	Less than 5 years.	Length of single track of this class.	23		* ;	: :	: : :		: :	r 1927. 907 594. : 80		35 lb.		the total
	Le le	Number of fractures.	2		: : :		: : :		::	nber: 28 gures:		613		nows t poss
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		Great Indian Peninsula Railway. (*)	35 lb. per yard 62 lb. —	75 lb.	88. lb.	Medium vails:	86 lb. –	(*) Year ended 31 December 1927, Number of train-miles : 28 907 594 Total number of fractures : 80		down	Miles of railway including sidings.	A) The above table shows the total mileage of each section of rails in use on the Great Indian Pennsula Railway and on which there were fractures. — B) It is not possible to give the total mileage according to an or record exists, but no rails of the following sections were ordered or mychased for the last 30 years 66 68 60 25, 80 38, 85 and 87 but he has a non-ingale cuton were ordered or mychased for the last 30 years 66 68 60 25, 80 38, 85 and 87 but he has a non-ingale cuton.

17	English tons.	17.93	17.95	:				res	lg oot	T		
16		11.67	:	11.67	ometres or			e of fracti	much rusted s not extendinuter face of for or head.		5.88	0
15	Miles.	1 660.87	:	1 660.87	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 14.82.		ice,	c) Percentage of fractures	with much rusted portions not extending to the outer face of foot or head.		τų	
14		ಣ	:	31	. 88°. 88°.		earar	0	1	-		
. 51		3.35	÷	3,35	mber of fractures per 10 000 6 250 000 train-miles : 14.82,		per appearance.	b) Fractures parts of which are old and much rusted.	2. Rusted part in the head.		23.53	100
13	Miles.	372.75	:	372.75	fracture O train-n	ф	ires as	es parts nd much				
11		٠٠	:	63	(mber of 6 250 00		Percentage of fractures	Fractur	1. Rusted part in the foot.		44,13	0
10		3.21	÷	3.21	N _U		age ((9)				
6	Miles.	194.750	:	194.750	Number 6 230		Percent	Fresh and clean	2. Without silvery oval mark.		11.76	0
oc.		~	:	-	OF			and				
-		:	:	**	i CLASSIFICATION			a) Fresh	With silvery oval mark.		14.70	T
9	Miles.	151,245	105.875	257.120	i IFICA	<u>:</u>	-					
,c		:	:	i.	LASS		tage	ges.	Clear of fishplate.		82.35	100
4		:	3.58	1.03	G	A	Percentage of	breakages.	red ate.		18	
e	Miles.	434.785	174.75	609.535	.000				Covered by fishplate.		17.65	0
2			-	p=4	. 35.			îği ni			34	-
	Madras and Southern Mahratta Railway.	Light rails: Less than 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per m. (85 to 106 iv. per yard).	Total	Number of train-miles: 14 757 200. Total number of fractures: 35.						Light rails	Medium rails.

							A	Age of rails	ails:							· p1
NAMES	Les	Less than 5	years.		5 to 10 ye	years.	-	10 to 15 ye	years.		15 to 20 y	years.	More	than	20 years.	001 910
ADMINISTRATIONS AND DESCRIPTION OF RAILS	Xumber of fractures.	Length of single track of this class,	Zumber of fractures or per 625 miles.	Xumber of fractures.	Length of single track of this class.	Xumber of fractures per 1 000 km, or per 625 miles.	Xumber of fractures.	Length of single track of this class.	Yumber of fractures per I 000 km, or per 625 miles,	Zumber of fractures.	Length of single track of this class.	Number of fractures per L 000 km. per L 000 km.	Number of fractures,	Length of single track of this class.	Number of fractures per 1 000 km.	ev mumixvIl
] L. W to	જ	80	4	10	9	1-	20	6.	10	11	12	13	7	15	16	12
(*) Light rails:		Miles.			Miles.			Miles.			Miles.			Miles.		English tons.
of a weight less than 42.5 kgr. per m. or 85 lb. per yard.	0	208.07	0	0	353.8	О	-	529.27	1.18	4	446.87	5.59	20	3 306.40	3.78	17.0
Medium rails: of 42.5 to 52.5 kgr. per m. (85 to 105 lb. per yard).	4	415.75	6.01	-	541.13	1.15	31	389.38	3.21	- ·	576.0	6.51	0	542.49	0	18.0
	771	623.82	:	-	894.93	:		918,65	:	10	1022.87	:	20	3 848.89	:	:
*) Year ending 31 March 192 Number of train-miles: 26 039 633, Total number of fractures: 38.	March 4928.	1928.	P						Number 6 250	250 00	of fractures per 10 000 train-miles: 9.	s per 10 (niles : 9.1	000 000	0 train-ki	train-kilometres	or
1	67		4	10	9	7	00	6	10	11	12	13	4	22	16	17
Rohilkund Kumaon Railway.																English tons.
Light rails: weight less than 42.5 kgr. per metre or 85 lb. per yard.	:	:	:	:	:	:	:	*	*	:	:	:	m	571.94	3,28	Q. 10.
Number of train-miles: 1 Total number of fractures	432 . 3.	.900							Number 6 250	ber o	of fractures per	. 13	000	00 train-k	000 000 train-kilometres	or
-	82	en	4	10	9	1-	oc oc	6	10	11	12	13	14	15	91	17
South Indian Railway.		Miles.			Miles.			Miles.			Miles.			Miles.		English
weight less than 42.5 kgr., per metre or 85 lb. per yard.		241.26	2.58	:	10.19	:	:	281.11	:	:	55.46	:	4	1 621.18	1.54	7.80(f) 8.15(g)
Medium rails: 42.5 to 52.5 kgr. per m. (85 to 10 lb. per yard).		56.89	:		53.14	1		:	:	:	:	:	:	0.25	:	10.00(*)
Number of train-miles: 9 ! Total number of fractures	577 69	.669							Numl 6	250 of	fracture O train-n	Number of fractures per 10 000 000 6 250 000 train-miles : 3.21.	90 00	0 train-k	train-kilometres	or
For 35 lb. rails (2) For	. 40 a	(2) For 40 and 41 1/4 lb, rails,	b. rails.	(n)	For 50 to	(4) For 50 to 75 ib. rails.	ails.							,		

=	sli .				Ч					
17	English tons.	128	- 4	17	English tons.		20.35	20.35	:	Sa
16		1.13	metres o	16			2,65	:	2,390	metres o
15	Miles.	1 105	traín-kilo	15	Miles.		5 883	95:0	6 512	train-kilo
14		હ્ય	000 0	14:			22	:	25	2° 000 2° 1
13		:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 2.66.	. 13			1.33	66*0	1.34	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 12.82.
13		:	ractures rain-miles	12	Miles.		5 883	629	6 512	fractures 0 train-m
Ξ			r of fi	II			13	1	14	er of 250 00
10			Numbe 6 250	10			0.85	3.97	1.15	Numl 6
6		•		o.	Miles.		58 883	629	6 512	
00		:	-	80			00	च्य	63	
7		* -		1-	,,		0.21	66.0	0.28	
9 .		:		9	Miles.		75 88 83	629	6 512	
10		:		70			હ્ય	-	n	
4		**		4			*.	i	:	
th		: ·	.05.	က	Miles.		76 80 83	629	6 512	347. \
8			692 2 S : 2.	63				:		325 8 5 54.
1	MALAY PENINSULA. Federated Malay States Railways. Light rails:	of a weight less than 42.5 kgr. per metre or 85 lb, per yard.	Number of train-miles: 4 692 205. Total number of fractures: 2.		AUSTRALASIA.	New South Wales Government Railways.	Light rails: of a weight less than 42.5 kgr per metre or 85 lb, per yard.	Medium.rails ; of 42.5 to 52.5 kgr. per metre (85. to 105 lb. pèr yard).	Total	Number of train-miles: 26 335 847, \ Total number of fractures: 54.

			i	5			1					
	prot etc	rv unuqxvJq	12	English tons,	74	les: 55	age of	-				
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	1 16		83	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles; 55. Number of fractures at joints; 6/) = 62% of total. Number of fractures away from joints: 36 = 38% of total.	Percentage total.	3.01	40.5	10.4	46	
	than	Length of single track of this class.	15	Miles.	1 445	or 6 250 0 of total.	i,					
	More	Mumber of fractures.	Ē		五	netres otal. 38°/.	Number	: 09	33	10	4	
	years.	Number of fractures per 1 000 km, or per 625 miles.	133		22.5	62% of the state o	Z					
	15 to 20 1	Length of this class.	12	Miles.	82.7	000 000 tats : 60 == from join			•		•	
		Number 10 tractures.	=		88	per 10 at join away						
of rails:	years.	Number of fractures per 1 000 km, or per 625 miles.	IO		17.3	fractures fractures fractures						
Age of	10 to 15 y	Length of single track of this class.	6	Miles.	434	umber of umber of umber of		rk mark	•		•	Ġ
		Mumber setures.	x		12	ZZZ	30.	al mark, oval m				and "
	years.	Number of fractures per 1 000 km, per 625 miles,	1-		3.83	rd.	FRACTURES	~ 0	ot	ad	•	th of Ireli
	5 to 10 y	Length of single track of this class.	9	Miles.	163	b. per yard	THE FR	with silvery over without silvery	in the foot	in the head.		n & Nor
		Number setutes.	5		-	er 85 1	OF '			~		Brital
	years.	Number of fractures per 1 000 km, or per 625 miles.	7"		1.43	ny rails over 85 lb.	PARTICULARS	of the rail	is old and much rusted,		is old and much rusted, outer surface of the foot	(See under ; « Great Britain & North of Ireland »),
	Less than 5 years	Length of single track of this class.	n	Miles.	434	year in al	PARTIC	whole	and		and muc surface o	e under
	Le	Number of fractures.	22			850 0 850 0 96.		in the	is old		is old	(Se
	NAMES	ADMINISTRATIONS AND AND DESCRIPTION OF RAILS	1	New Zealand Government Railways.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	No fractures occurred during the year in any Number of train-miles: 10 850 000. Total number of fractures: 96.		a) Fresh and clean fracture section.	b) Fracture, part of which is old	head of the rail	c) Fracture, part of which is old and much rusted not extending to the outer surface of the fool or the head of the rail	County Donegal Railways Joint Committee. Great Northern

	16 toad	no mumixaN.	12	English tons.	60°		17	English tons.	9.1	
		of fractures per 1 000 km. or per 625 miles.	16	Er	16	lometres	16	ug v	84.16	ometres
	years.	of this class.	l5	Miles.	38 5.	 train-ki	15	Miles, More than 1 years.	126 84	train-kil
	37	of fractures.	-	¥	QT3	- 000 64.		Miles. More than 20 years.		000 000 404.22
		of fractures per 1 000 km, or per 625 miles,	-			er 10	4		17	er 10 nîles :
	years	Number serures	13		:	tures	. 13		:	tures p
	15 to 20	Length of single track of this class.	12		:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 64.	12		*	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 404.22
		Number of fractures.	=		:	Number or 6	=		:	Numb
rails:	rears.	Number to tractures to to t	10		*		10		:	
Age of rails	10 to 15 years.	Length of single track of this class.	6		*	_	6		:	
W		Number of fractures.	20		:	_	oc .		:	
	ears,	Number of fractures per I 000 km. or per 625 miles.	t-		:	1	da.		;	*
	5 to 10 years,	Length of single track of this class.	9		;	=,			÷	
		Number of fractures.	ī.	ı	.:		70		:	
	years.	Number of fractures per 1 000 km, or per 625 miles,	7		:		4		•	
	Less than 5	Length of single track of this class.	so .				ers	· ·		ai .
	Les	Number of fractures.	يد		:	98 380 18 : 1.	2		:	e 333
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS.		GREECE. North Western Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 98 380. Total number of fractures: 1.	-	Thessaly Railways. Light rails: of a weight less than 42.5 kgr.	per metre or 85 lb. per yard.	Number of train-miles: 261 332, Total number of fractures: 17,
		DESCI			of a We	ZF		The		ZE

pı	ooi elan mu.		10		16.2			16.7		:		etres or
Number	of fractures per 1 000 km.	or 625 miles	6		₹.		1 241)	12 } 76	:	:	800	090 train-kilom
Approximate	length of the lines considered	as single line.	8 Wiles	Wiles.	8 596		192	3 500	3 692	. :	12 288	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 112.
	TOTAL.		7		1 174		385	75	457	0 0	1 631	Number of frac
	More than 30 years.	Number of fractures.	9		977 (1)			:	:	0 0 0	776	
for	20 to 30 years.	Number of fractures.	τυ		114		41	6	13		127	
Rails in use for	10 to 20 years.	Number of fractures.	भा		10 81		335	II.	386		438	
Ra	5 to 10 years.	Number of fractures.	m		64		45	11	56		77	
	Less than 5 years.	Number of fractures.	72		10		·	-4	63	*	12	945 100.
NAMES	ADMINISTRATIONS AND DESCRIPTION	of RAILS,	ITALY.	State Railways.	Light rails of a weight less than 42.5 kgr, per metre or 85 lb, per yard,	Medium rails: of 42.5 kgr. per metre (85 lb. per yard)	In tunnel.	In the open	Total	Heavy rails: of a weight equal to or greater than 53 kgr. per metre or 106 lb. per yard.	Total general	Number of train-miles: 89 945 100. Total number of fractures: 1 631.

Acts.—As we have already had occasion to remark when returning the figures for 1926, most of the fractures of raits have occurred in tunnels at the boil tolors. In order to one as first shooting, which make the maintenance of the points very laborious and difficult, we are using at the joints themselves bearing plates with the object of making the joints more rigid and less sensitive to blows from tyres.

⁽¹⁾ Most of these rails were put into service more than forty years ago.

		. 12001 s	lan mumixaM		English tons.	14.76		-
		20 years.	A mber of fractures per 1 000 km. T per 625 miles.		16 EB	33.8	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 33.1. fishplates and 67.2 % in the part clear of the fishplates	
		More than	Length of single track of this class.		I5	2 9.6 1	train-kii	
		- X	Number of fractures,		4	157	00 000 1.	
		years,	Number of fractures per 1 000 km.		13	67.5	s per 10 000 lies : 33.1.	
		15 to 20	Length of single track of this class.		12 Miles.	1 140.2	mber of fractures per 6 250 000 train-miles :	
			Number of fractures.			123	ber of 250 00	
	rails:	years,	Number of fractures per 1 000 km.		10	35.1	Numl 6	
	Age of rails	10 to 15	Length of this class.		9 Miles.	1.22.	rered by	
Ì			Number fractures.		00	63	il cov	
		/ears,	Number of fractures per 1 000 km, or per 625 miles,		-	36.9	of the ra	
		5 to 10 years,	Length of single track of this class,	55 677.	6 Miles.	1 560.2	wn age). the part	
			Number of fractures.	1927. les: 5	ಬ	692	nkno ed in f rails	
		s years.	Number of fractures per 1 000 km, or per 625 miles,	ctures in train-mil	ক	14.9	ng 13 of 1	
		Less than 5	Length of single track of this class.	No rail fractures in 1927. Number of train-miles: 555 No rail fractures in 1927.	3 Miles.	2 556.2	894. 9 (includi	
_		Le	Number of fractures.	ZZZ	es.	19	96 355 s : 50 abov	
		NAMES or	ADMINISTRATIONS AND DESCRIPTION OF RAILS	Tessin Railways. Società Trazione Elettrica Lombarda.	Japanese, Government	(*) Light rails: Light rails: of a Weight less than 42.5 kgr per metre or 85 lb. per yard.	(*) Year 1926. Number of train-miles : 96 355 894. Total number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 33.1. Note. — 32.8 % of the above fractures occurred in the part of the rail covered by the fishplates and 67.2 % in the part clear of the fishplates. (Information based on the statistics of breakages of rails for 1926).	

							A	Age of rails	ails:							
NAMES	Le	Less than 5 years	5 years.		5 to 10 years.	ears.		10 to 15 years.	ears.	-	15 to 20 years	ears	More	More than 2	20 years.	pขo1 อาว
ADMINISTRATIONS AND DESCRIPTION OF RAILS	Number of fractures.	Length of single track of this class.	Number of fractures per I 000 km, or per 625 miles,	Number of fractures.	Length of single track of this class.	Number of fractures per I 000 km. or per 625 miles	Number of fractures	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles.	Xumber of fractures.	Length of single track of this class.	Number of fractures per 1 000 km. or per 625 miles	Xumber of fractures.	Length of this class.	Number of fractures per 1 000 km. or per 625 miles.	rv munuşxvJy
LUXEMBURG Guillaume-Luxemburg Railways.		See under	See under « Alsace and Lorraine Railways ».)	and	Lorraine	Railways.	<u>;</u>									
	n		4	10.	~	(~	00	6	0.	=	62	er.		100	,	17
Prince Henry Railway.		Miles.			Miles.			Miles.			Miles.			Miles.		English
Light ralls: of a weight less than 42.5 kgr. per metre or 85 lb, per yard.	0	16.000	0	ক্য	10.006	124.2	€\	21.2.16	51.2	e .	22.214	83.9	4	32.092	77.4	15.7
Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard.)	0	20.225	-	0	Ç.6.2.0 . +	c	0	8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8. 8	0	:	i	:	:	:	:	5
Total	0	36.225	0	6%	14.686	84.6	- - -	33.128	37.5	50	22.214	83.9	-	32.092	77.4	:
Number of train-miles: 978 186. Total number of fractures: 11.	378 18 1: 11	. 36.						-	Z	or 6	of fracti	nber of fractures per 10 000 0 or 6 250 000 trains-miles; 70,	10 000 es : 7	000 trail	Number of fractures per 10 000 000 train-kilometres or 6 250 000 trains-miles ; 70.	es S

1						
	pool a	nas mumixaM	Pounds.	40 320	es: 154.	
TOTAL		Per l 000 km. or per 625 miles		8.09	train-mile	
TO,		Number of fractures.		6 250 000	·	
	1 20 years.	Number of fractures per 1 000 km, or per 625 miles,	,	21.3	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 154.	At the joint: 32 %. a) New clean break: 48 %. b) With rusted part: 1. in the base: 41 %; 2, in the head: 4 %. c) With other oxidisation: 7 %. d) Number of pieces of broken rail: 2 pieces: 97 %; 3 pieces: 3 %.
	Number of fractures. Of fractures. Number of fractures. Of fractures. Number of fractures.			13	oo train-kil	2, in the he :: 97 %; 3 ;
Water Sample	Length of single track of this class. Number of fractures.		,	2.0	r 10 000 0	the joint: 32%. New clean break: 48%. With rusted part: 1, in the base: 41%; 2. With other oxidisation: 7%.
44	\$			2	tures pe	he base o/0.
Age of rails	Number of tractures, of tractu			26.8	ber of frac	the joint: 32%. New clean break: 48%. With rusted part: 1, in the 1 With other oxidisation: 7%. Number of pieces of broken i
Age	Number of tractures.			65	Nunî	t: 32 %. an break sted part er oxidii
	years.	Number of fractures per 1 000 km. or per 625 miles.		10°		- At the joint: 32%. - a) New clean break: 48%. b) With rusted part: 1, in c) With other oxidisation: d) Number of pieces of brol
1	t 0	Number of fractures.	'	22		A At $B a)$ $b)$ $c)$ $a)$
	years.	of fractures, may 000 f raq		7.0 7.0	ons.	**
	than 5			16	.42 millic	ractures
जुरु	gle tra	Length of sing	Miles.	2 131	about 8	on of f
NAMES	NAMES OF ADMINISTRATIONS AND DESCRIPTION OF RAILS.		NORWAY.	Light rails.	Number of train-miles : about 8.42 millions. Total number of fractures : 209.	Classification of fractures

		ppo1 210	op unuşav _s ı	17	English tons.				15.7	19,7		:	00
		20 years.	Number / Aumber / Outpetures per 1 000 km, or per 625 miles,	16					112	:		:	or 6 250 0
		than	Length of single track of this class,	15	Miles.				756	55.9		:	ometres
		More	Number of fractures.	14					167	:		167	uin-kil
		years.	Number of fractures per 1 000 km, or per 625 miles,	13					ارد	40.			Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 50.
		15 to 20	Length of single track of this class.	12	Miles.				646	14.9		:	s per 10 (
			Xumber of fractures.	=					21	-		37	ecture 50.
	rails:	years.	Number of fractures per 1 000 km. or per 625 miles.	01					582	40		:	umber of fractu train-miles: 50.
	Age of rails	10 to 15 y	Length of single track of this class.	5	Miles.				454.8	281.5.			Num] trai
ı	4		Yaumber setures.	20					200	34		22	
		ears,	Kumber of fractures per 1 000 km. or per 625 miles.	-					24	02	ails.	:	
		5 to 10 years,	Length frack of this class.	9	Miles.				343.0	252,3	heavy n	:	
			Number of fractures.	2					* · ·	30	ot use	20	
		5 years,	Kumber of fractures per 1 000 km, or per 625 miles,	4					5 0	2	The Company does not use heavy rails.	:	
		Lese than 5	Dength of single track, to the strack.	က	Miles.				159.1	154.1	compan		.000.
١		Ë	Mumber of fractures.	23					63		- ď	٠c	305
		NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS			S Y I O	HOLLAND.	Netherlands Railways.	Light rails: of a weight less than 42.5 kgr. per m. or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per m. (85 to 105 lb. per yard).	Heavy rais: of a weight equal to or greater than 53 kgr. per metre or 105 lb. per yard.	Total	Number of train-miles: 29 205 000. Total number of fractures: 236.

	The attention of the permanent way staff is not yet sufficiently directed to noticing fractures with silvery oval marks.
Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb, per yard).	85 % 15 %
Light rails: of a weight less than 42.5 kgr, per m. or 85 lb, per yard.	57 % 43 % 38 % 57 % 57 % 90 % 10 %
	A.—Percentage of fractures in the respective portions of the rails: a) Covered by the fishplates. b) Clear of the fishplates. c) Clear of the fishplates. 3. Without silvery oval mark. 2. Without silvery oval mark. 3. Without silvery oval mark. 4. Fractures, part of which are old and much rusted, extending to the outer face of the foot or head of the rail: 1. Rusted part in the head. 2. Rusted part in the head. 3. Fractures with much rusted parts not extending to the outer face of the foot or head of the rail: 4. Number of pieces into which the rail is broken: two 4. Number of pieces into which the rail is broken: two 4. Lusted parts not extending to the outer face of the foot or head of the rail.

	pmog mga	ev unuixnsi	17							:	:	:		
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	16				61	~~		:		:	:	-
	More than 2	Length of single track of this class.	15	Miles.				1 325		:		:	:	
	Mor	Number of fractures.	14				(n) 4	24(2)	800	5	9 6	(T)	(+)9	
	/ears,	Number of fractures per 1 000 km. or per 2 000 km.	EJ .				:			:	•	***	:	_
	15 to 20 years.	Length of single track of this class.	12	Miles.			\$2			:	:	:	:	
		Number of fractures.	=				:	:		:	:	:	:	_
rails:	years.	Number of fractures per 1 000 km, or per 625 miles,	10					:			:	:		.(6
Age of rails	10 to 15 y	Length of single track of this class.	6	Miles.			449	:			:	:	:	complete
		Number of fractures	00				:	:			:	:	:	s not
	ears,	Number of fractures per 1 000 km. or per 625 miles.	7			1	i	:			:	:	:	(In two cases the fracture was not complete).
	5 to 10 years.	Length of single track of this class.	9			,	316	:			:	:	:	es the fra
		Number of fractures.	22				:	:			:	:	:	o cas
	years.	Number of fractures or per 1 000 km. or per 625 miles.	4				:	:			:	:	:	
	Less than 5 years	Length of single track of this class.	က			,	412	:	:		:-	:	:	n rail : \$
	Les	Number of fractures.	37				:	:			:	:	:	, broke
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS		COLONIES.	Dutch India State Railways. (Java, Sumatra and Celebes).	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number and percentage of fractures in the portion of the rail covered by the fish plates.	Number and percentage of fractures clear of the fish plates.	Number and percentage of: a) Clean and fresh breaks through the whole of the rail section	b) Breaks with old part extending to the outer surface of the:	l. Foot of the rail	. d.	not extending to the outer surface of the real	d) Number of pieces of the broken rail: 2.

Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 12.25.

(1) 14.4 0/0. — (2) 85.6 0/0. — (3) 32.2 0/0. — (4) 21.2 0/0.

Number of train-miles: 14 196 016. Total number of fractures: 28.

English tons.	17 English tons.	18	18	: :	ive
16 4 n-kilomet	.16	102	13	kilometre	an only g
Miles. 146 00 000 trai	15 Miles.	7 061	99	000 train	cations c
14 10 00 iiles :	4	1164	2 1100	0000	ımuni orded
12 14 M M M M M M M M M	133	62	: %	res per 1(ry of com been rec
11 12 13 14 5 16 E1 E1 Miles. E1 Miles. E1 Miles. E2 Miles. Mi	12 Miles.	. 763	3 061	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 157,	the Minist ot having rface of th
711 Varmb	=======================================	185	: 32	mber or 6	rred, rred, er su
92 :	01	51	9 46	, g	res occu
ъ :	9 Miles.	2 105	287		the fractual (silvery tending to 14%.
B	00	173	3 176		hich 55 % ne rai d, ex
7 w in the		39	: 5		under w he joint: tion of th uch ruste d of the r ace of th
1, and ne	6 Miles.	230	362		nastances. clear of ti he full sec and m he hea
se rai	ئر	18	: 8		ws: and and ugh the is control to the is control to the
 nt:1.	4	ĸ	:: 23		to the is follo: 45 % strong which which is which is ding to
he joi					lating only s joint acture part o vith r
36. 36. 13. 13. 13. 13. 13. 13. 13. 13. 13. 13	uil. 3 Miles,	1 012	.:. 1 013	 	res re rails of the front from the front f
657 5 1:1.	rd) rs	40	: 8	. 1 58 . 1 58	y figut light dures lean r fract fract
Dutch India Pailway Company. Pailway Company.	(1) 33.5 kgr. (67.60 lb, per yard) rail 1 POLAND. State Railways.		of 42.5 to 52.5 kgr. per m. (85 to 105 lb. per yard).	(*) Year 1926. Number of train-miles: 62 760 000. Total number of fractures: 1 585.	As regards supplementary figures relating to the circunstances under which the fractures occurred, the Ministry of communications can only give A.— Percentage of fractures in the joint: 45 % and clear of the joint: 55 % and clear of the joint: 45 % and clear of the joint: 55 % and clear of the fail section of the rail (silvery oval marks not having been recorded): 41 % b) 1. Percentage of fractures, part of which is old and much rusted, extending to the outer surface of the rail. b) 2. Percentage of fractures with rusted part in the head of the rail: 14 % 6. c) Percentage of fractures not extending to the outer surface of the foot or the head: 15 % 6.
Rai of a w of a w T T T The No The Bro	(1)	of a we	of 42	*) XI	dďe

	p001 913	xv unuixoff	11	English tons.	:	17.33	:	or	17	English tons.	17.7	19.7			added. class assify arance
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	16		499.1	101.5	:	ilometres	16		169.96	:	166.75	n-kilometı	must be and of each sible to c
	than	Length of single track of this class.	12	Miles.	1 161.420	24.482	937 1 185.902	00 train-k	15	Miles.	6 720	130	6 850	0 000 trai	own age track li s not pos realed by
	More	Number of fractures.	44		933	4	937	000 00	14		1838	:	1838	10 00 ss : 4	unkr singl y it i il rev Congr
	years,	Yumber of fractures per 1 000 km. per 625 miles.	13		:	21.2	:	mber of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 931.2.	13		10.17	4.78	10.07	nber of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 447,	To the table above, 342 fractures of rails of unknown age must be added. The statistical returns do not give the lengths of single track line of each class of rail grouped according to age. In the same way it is not possible to classify the fractures according to the defects in the metal revealed by the appearance of the section, etc., as laid down by the London Congress.
	15 to 20 years,	Length of single track of this class.	12	Miles.	:	29,221	29.221	Number of fractures 6 250 000 train-mi	12	Miles.	6 720	130	6 850	er of frac 6 250 000	actures ogive the leg. In the defects in which was by the
		Number fractures.	=		:	0	<u> </u> :	1ber 250	=		110	1	111	Number or 6	42 fr. not to age the the
of rails:	15 years,	Mumber of fractures per 1 000 km. or per 625 miles.	01,		:	16		Num	10		6.47	4.78	6.44	Z	above, 3 turns do ccording ording to c., as lai
Age of	10 to 15 y	Length of single track of this class.	6	Miles.	*	34,712	38.712		6	Miles.	6 720	130	6 850		the table tistical re grouped a tures acc
		Number of fractures.	œ		:	proof	-		00		2	-	112		To star trail tractthe s
	10 years.	Number of fractures per 1 000 km. or per 625 miles.	2		:	:	:		7		2.22	4.78	2.26		Th of of
	5 to 10 y	Length of single track of this class.	9	Miles.	:	32,389	32.389		9	Miles.	6 720	130	058.9		
		Number of fractures.	T.			. 0			5		24	-	25		
	5 years.	Number of fractures per 1 000 km. or per 625 miles.	4		3.6	:	:		4		2.13	76.55	3.53		
	Less than	Length of single track of this class,	က	Miles.	156.029	65.833	221.862	.643. 39.	00	Miles.	6 720	130	6 550	33 714 353 es : 2 426,	850 miles 399. int: 1 727
	L	Number in fractures.	24		~	0	~	3 265. 8 : 90	63		82	16(1)	39	les:	k : 6 nt : 6 le joi
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	TA STANGO	Portuguese Railway Company.	Light rails: of a weight less than 42.5 kgr. per metre (or 85 10, per yard).	Medhun rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total	Number of train-miles: 6 265,643, Total number of fractures: 939.	prod *	ROUMANIA. State Railways.	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb. per yard.)	Total	Number of train-miles: 33 714 353 Total number of fractures: 2 426,	Total of single track : 6 850 miles. Fractures at the joint : 699. Fractures outside the joint : 1 727

-	English tons.		15.7	:			17						:	:	
29			224	51	216	ometres	16				* ** ** *** ****		i	-	
. 55	Miles.		3 465	159	3 624	 train-kil	15 7	Miles.			2 147		 :	.	_
+			1248	13	1921	00 00	14				118	<u>_</u>	:		_
133			88	8	18	 per 10 0 es : 350	13				:	3 1	:	:	-
32	Miles.		329	162	521	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 350	. 21	Miles.			5 147		:	:	-
==			33	24	46	ber of	11				6		<u>:</u>	<u> </u>	_
10			67	16	56	Num 6 2	10				:		:		•
Ģ.	Miles.		378	113	491.		6	Miles.			5 147		:		
00			14	₀	1 44		co				10			:	
t-			ံ	230	5		7					-	:		•
9	Miles.		702	20	710		.9	Miles.			5 147		:	:	
rtş			1-	က	=		70				20		:	:	
प्			88	:	89		4				. :		:		
ca	Miles.		22S	1-	235	585.	en ,	Miles.			5 147		247	5 394	
28" .			33	:	33	1 38 : 1 38	64			_	17		15	:	1:: 209.
	KINGDOM OF SERBIA, CROATIA AND SLOVENIA.	State Railways. (Standard gauge lines.)	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails: of 42.5 to 52.5 kgr. per metre (85 to 105 lb, per yard).	Total,	Number of train-miles: 24 597 585. Total number of fractures: 1 386.		SWEDEN.	State Railways.	Light rails:	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Medium rails	of 42.5; to 52.5 kgr. per metre (85 to 105 lb, per yard).	Total.	Total number of fractures ; 209.

	proof ela	o mumixaM	17	English tons.	12.3	17.0	or	17	English tons.	13.8	27.		
	20 years.	Number of fractures per 1 000 km. or per 625 miles.	16		ಹ್ಲಿದ್ದರ ಬೆಗ್ಗಳ	0 0 0	ilometres	16		*	stem in 19		
	than	Length of this class.	15	Miles.	200.1		00 train-k	15	Miles.	(11.8(2)	on this sys		A-00-
	More	Number of fractures.	4-		8-8	:::	3.000	14		:	ails c		
	years.	Number of fractures per 1 000 km. or per 625 miles.	13		:::		Number of fractures per 10 000 000 tauin-kilometres or 6 250 000 train-miles ; 13,3,	13		:	No broken rails on this system in 1927.		
	15 to 20 y	Length of single track. of this class.	12		:::		of fractur 000 train	129	Miles.	1.2(1)	No	.00	yard).
		Number 10 fractures.	=		1::		nber 6 250	=======================================		:		347 66	per
rails:	years.	Number of fractures per 1 000 km, or per 625 miles.	10		41.7	9.64	Nan	10		*		Number of train-miles:847 660	32 kgr. per m. (64.51 lb. per yard).
Age of rails	10 to 15 y	Length of single track of this class.	6	Miles.	. 22	216.2 216.2 206.3		6	Miles.	26.1(1)		er of train	per m. (
V		Number of fractures.	∞		ಟ ಕ್ರ	:- :		20		:		umbe	kgr.
	years.	Mumber of fractures per 1 000 km. or per 625 miles.	-		! ! !	17.6 8.8 17.6		ę		:		1	Weight: 32
	5 to 10 ye	Length of single track of this class.	9	Miles.	80.8	07 8 8 8 8		9	Miles.	15.5(1)		ystem iu	8
		Mumber of fractures.	70		1::	≈-×		. 30		:		his s	d). –
	years.	Mumber of fractures per 1 000 km. or per 625 miles.	4		:::	62.5		*		:		No broken rails on this system in 1927,	per in. (83.01 lb. per yard).
	se than 5	Length of this class.	63	Miles.	10.6	9.00 10.00 10.00	220.	-00	Miles.	7.5 (1)	49.	o broken	(83.01.15
1	Less	Number of fractures.	67				796 220.	82		:	682 1	Ż	er m
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF BAILS.	1	Geffe-Dala Railway.	Light sails: of a weight less than 42.5 kgr, per metre (or 85 lb, per yard). 1927	Medium rails: of 42.5 to 52.5 kgr. 1925 per metre (85 to 105 lb. per yard.) 1927	(*) Years 1925 to 1927. Number of train-miles : 2	-	Goteborg-Borås and Borås-Alfvesta Railway.	of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 682 149	Halmstad-Nässjö Railway.	1) Weight : 41,18 kgr. pe

sh											
I7 English tons.	13.8	tres	17 English tons.	16.2	es S	17	English tons.	4.65			
16	33.8	ı-kilome	16	:	kilomet	91		\$	-		Number of train-miles; 253 812.
15	0 0)00 train 6121	15 Miles.	121)0 train-	. — 35	Miles.	106.0	-		n-miles
2	4	10 000 les : 64.	14	-	10 000 0 68 : 14.	14	R	× ×	- - - - -		r of trai
13	:	ures per train-mi	13	*,	res per rain-mil	13		:	ctures :		Numbe
13	:	or 6 250 000 train-miles: 64.6121	21	:	nber of fractures per 10 000 or 6 250 000 train-miles : 14,	12		:	er of fre		
Ξ	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 64.6121	11	:	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 14.	111		:	Total number of fractures: 8.		
01	<u></u>		10	:	f≒ ,	IO		:	Tot		
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!~	: 			;		1-		:		n 1927.	
9	:	÷	, 9	i		9		:		No broken rails on this system in 1927,	• /
10	:	stations	, TO	:		2		:		on this	is in 192
4	:	irring in	4	:		4		:		en rails	urea ran
m ·	:	ő. (all occu	ಣ	:	*	ಣ		:		No brok	No tractured rails in 1921,
25 EII		: 384 68 res : 4	ev .		: 444 04. res : 1.	63	ģ	:	392 182		
sslehol	: n 42.5 kg ard;	in-miles of fractu	ailway	1 42.5 kg ard,	in-miles of fractu		kfors- relfven ra- ilway.	42.5 kgr ard.	n-miles	hamn gen	
oorg-Hess Railway.	Light rails: reight less than 42., per metre or 85 lb, per yard;	Number of train-miles: 384 685. Total number of fractures: 4 (all occurring in stations),	1. ar-Nya Rai Light rails:	eight less than 42 per metre or 85 lb. per yard.	Number of train-miles: 444 042. Total number of fractures: 1.	7	arlstad-Munkfor. rdmarks-Klarelfv Filipstads-Nora- rgslagen Railwa	Light rails: weight less than 42.5 per metre or 85 lb. per yard.	Number of train-miles: 392 182.	fässjö Oskarsham Railway. Nora-Bergslagen	naliway.
1 Helsingborg-Hessleholm Railway.	Light rails: of a Weight less than 42.5 kgr. per metre or 85 lb, per yard;	Numb	1 Kalmar-Nya Railway. <i>Light rails</i> :	of a weight less than 42,5 kgr. per metre or 85 lb. per yard,	Numb Total		Karlstad-Munkfors- Nordmarks-Klareffvens- Filipstads-Nora- Bergslagen Railway.	Light rails: of a weight less than 42.5 kgr. per metre 1, or 85 lb, per yard.	Numbe	Nässjö Oskarshamn Railway. Nora-Bergslagen	
He	jo		K	of			N S S	of a			

	proj ejs	no mumixall.	17	English tons.	œ.	or			English tons.	15.2	or
	20 years	Number of fractures per 1 000 km. or per 625 miles.	16		102	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 192.6.		9		FC	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 17.4.
	than	Length of single track of this class.	15	Miles.	54.7	00 train-k		ur.	Miles,	981	00 train-l
	More	Number of fractures.	7		a	000 0		7		53	000 0
	years.	Number of fractures per 1 000 km, or per or miles.	13		:	es per 10 niles: 192		<u> </u>		62.4	es per 10 niles : 17.
	15 to 20 y	Length of single track of this class.	12		:	umber of fractures per 10 000 6 250 000 train miles: 192.6.		27	Miles,	186	imber of fractures per 10 00 6 250 000 train-miles : 17.4.
		Number of fractures.	=		:	250 0				25	1ber 250 (
ails:	15 years.	Number of fractures per 1 000 km, or 1 selfm 23 nor 10	10		:	Num :		10		\$0.8	Num 6
Age of rails	10 to 15 y	Length of single track of this class.	n		:			. p	Miles.	186	
		Number setures	တ		:					1-	
	years.	Number of fractures per 1 000 km. per 1 000 km. selim 625 neg to	1		:			1		6.7	
	5 to 10 ye	Length track series to seals sint to	9		:		1:	9	Miles.	186	
		Mumber of fractures.	5				n 192	FU.		64	
	years.	Number of fractures per 1 000 km. or per 625 miles.	4		:		No fractured rails in 1927.	d.		2.82	
	Less than 6 years.	Length of single track of this class,	80		: .	37.	No fractu	ಣ	Miles.	186	747.
	٦	Number of fractures.	24			284 49		G-1			3: 83.
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	· ·	Norra-Östergötland Railway.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles: 284 497, Total number of fractures: 9	Norsholm-Westervik Hultsfred Railway.		Oxelösund- Flen-Westmanland Railway.	Light rails: of a weight less than 42.5 kgr. per m. or 85 lb. per yard.	Number of train-miles: 29 564 747. Total number of fractures: 83.

•						EFFAn B	
English tons.		:	:	·	M	. 20 	
16 16	116	9.3	:	metres o	91	. :	
Miles.	15 Miles,	8998	÷	train-kilo	<u> </u>	10 A	res or 6
4	4	4	:	000 00	4	<u></u>	ilomet
1	<u>.</u>	:	:	Number of fractures per 10 600 600 train-kilometres or 6 250 600 train-miles: 20.	13		Number of fractures per 10 600 600 train-kilometres or 6 250 600 train-miles : 0.
***	25	:	;	fractures	22		er 10 600 (
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0	. 10	:	:	Numb 6	10	er≛m	tumber of fractu train-miles : 0,
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\$	Miles.	:	29.8		9	17 (4 7) 18 1 #10## (3 1	
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•	64	1 2	:.	1 222	er ;		88 771 5: 0.
Stockholm-Roslagens Railway. Light rails: of 22.8 kgr. per metre (45.96 lb. per yard.)	l. Stockholm-Västerås Bergslagen Railway	Light rails; of 40.5 kgr, per metre (81.64 lb, per yard).	of 43.5 kgr. per metre (87.69 lb. per yard).	Number of train-miles: 1 222 790. Total number of fractures: 4.	Västergötland-Göteborg Railway.	Dight rais, of a weight less than 42.5 kgr. per metre or 85 lb. per yard	Number of train-miles; 368 771. Total number of fractures: 0.

	ppol ele	ov innuixo y	17	inglish tons.	20.1	:		, 5	14 English	tons.	19.5	19.7	:	
	0 years.	Number of fractures per 1 000 km, or per 625 miles,	16	:	:	:	metres or	9	9		:	:	-	
1	e than 20	Length of single track of this class.	15	:	:	:	10 000 000 train-kilometres 84.3.		Miles		19.211		19.211	*****
	More	Number of fractures.	=	159	136	1 = =	000	2	Ť		:	:	1 :	8
	20 years.	Mumber of fractures per 1 000 km. or per 1 000 km.	13	:	:	:	per 10 000 les : 84.3.	ç	27		*	:		non 000 000 man
	15 to 20 y	Length of single track of this class,	27	:	:	:	Number of fractures per 6 250 000 train-miles:	2	Miles.		1.243	:	1.243	fractiones
		Number of fractures.	=	т	SS SS	127	er of 50 00 ails.	=	-		:	:	1	or of
rails:	15 years.	Mumber of fractures per 1 000 km, or per 625 miles,	10	:	:	:	0	01	2		103	861	125	Number of
Age of rails	10 to 15 y	Length of track to single track to see the construction of this class.	6	:	:	:	to the ag	q	Miles.		42,128	12,551	54.679	
		Mumber estures	x	ت د د	- 88	33	ding	O.	2		1-	4.	=	
	years.	Number of fractures per I 000 km.	-	:	:	:	tely accor	6			:	:	:	
	5 to 18 y	length of single track of this class.	9	:	:	:	on separa	۳	Miles.		0.947	2.141	3.091	
	Ago.	Number of tractures.	iC.		01	Ξ	matic	10			:	:	:	
	5 years.	Number of fractures per 1 000 km, m/ 000 t neg or or per 625 miles.	4	:	:	:	this infor	7			:	1266	069	
	Less than	Length of single track of this class.	e2	:	. :	:	294.	er.	Miles.		4.498	5.397	9,895	360.
	ت	Number of fractures.	34	C	4	4.	. 21 (res:	6				=	=	842
	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	· SWITZERI AND	Federal Railways, Total: 1 679 miles, Light-yours: of a weight-less than 42.5 kgr. per metre or 85 lb, per yard,	Total: 1876 miles. Medium vails: of 2.55 to 52.5 kgr. por metre (85 to 105 1b. per yard).	Total: 3 555 miles.	Number of train-miles: 21 651 686. Total number of fractures: 294. Note. — It is not possible to supply this information separately according to the age		Berne Alpine	Berne-Loetschberg- Simplon.	1999	Medium valls: of 42 5 to 52.5 kgr. per metre (85 to 105 lb. per yard).	Total	Number of train-miles: 842 360

II English tons.	. 51	17 English tons.	12.51	E.	I7 English tons.	12.51		17 English tons.	12.51	
29	:	16	:	metres o	16 B	:	metres or	16 E	75.3	metres or
15 Miles.	13,467	I5 Miles.	4.655	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles : 0.	155	9.410	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles; 0,	15 Miles,	16.501	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 65.36.
*	:	4	:	000 000	4	:	000 000	14	€5	000 00
22	ŧ	13		s per 10 les : 0.	113	:	per 10 0 les: 0.	13	:	per 10 0
<u>e</u>	:	22		fracture train-mi	221	i	fractures train-mil	83	:	fractures train-mil
=	:	prod prod	:	ber of 250 000	II.	:	ther of	=	<u>:</u>	ber of 50 000
10	:	10	:	Num 6	01	:	Num 6 2	10	:	Num 6 22
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:0	:	6 Miles.	912.0		6 Miles.	1.212		6 Miles.	0.342	
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Miles.	1.3%	3 Miles,	1.678		3 Miles.	1,212		3 Miles.	1.864	
Cr)	82 33	6.	:	50 503. s: 0.	R		85 526. ss : 0.	G5		90 134. s: 2.
b) Erlenbach- Zweisimmen Line.	of a weight less than 42.5 kgr. of a weight less than 42.5 kgr. or 85 lb. per yard. Number of train-miles: 82 324. Total number of fractures: 0.	1 c) Spiez-Erlenbach Line.	Light rails: of a weight less than 42.5 kgr. or 85 lb, per yard.	Number of train-miles: 50 503. Total number of fractures: 0.	1 d) Bern-Schwarzenburg Line.	Liont rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard.	Number of train-miles : 85 526. Total number of fractures : 0.	1 e) Gürbethal Line.	Light rails: of a weight less than 42.5 kgr. per metre or 85 lb. per yard,	Number of train-miles: 190 134. Total number of fractures: 2.

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	. pwo1 913	хо шпшэхүү	English tons.	5	<u>-</u>	the the
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	than	Length of single track of this class.			Miles.	ure of th
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	15 to 20 ;	Length of single track of this class.	i i i	train-min	22 :	of fractures; of
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		Number of fractures.	:		80 80-	in t
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	20 years.	Number of fractures per 1 000 km, or per 625 miles.	91				78.5		6.7	74.6	metres or	
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	years.	Number of fractures per 1 000 km per 625 miles	23			-	30.1		13.8	. 25.3	Number of fractures per 10 000 000 train-kilometres or 6 250 000 train-miles: 72.3.	
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	years.	Number of fractures per 1 000 km, or per 625 miles,	7				7.1		9.6	5.4		No fractures of rails in 1927,
	Less than 5	Length of single track, of this class.	ಣ	Miles.			524.6		634.1	1 158.7	811.	o fracture
	Le	Number of fractures.	27				9		4	10	6 317 8 : 77	<u>.</u>
. •	NAMES	ADMINISTRATIONS AND DESCRIPTION OF RAILS	_	CZECIIOSLOVAKIA.	State Railways.	Light rails;	of a weight less than 42.5 kgr. Per metre or 85 lb. per yard.	Medium vails:	(85 to 105 lb, per.yard).	Total,	Number of train-iniles; 66 317 811, Total number of fractures; 772.	URUGUAY. North Western of Uruguay Railway.

MISCELLANEOUS INFORMATION

[624. (0 & 669 .1]

1. — The use of silicon steel in the construction of railway bridges.

The German review Die Bautechnik, No. 22 of the 25 May 1928, contains an interesting article by Mr. Schaper on a voyage of investigation in Switzerland. He gives particulars of a single line railway bridge built over the Aar canal, at Brügg, the structure of which is in silicon steel. (Si Stahl.) The main trelliswork girders are built in two bays each of 55 metres (180 ft. 5 1/2 in.) span. The total weight of steel, is 300 tons.

The silicon steel was supplied by the Wendel steel works in Alsace-Lorraine and by the Burbach steel works. The metal is uniform and of excellent quality. It met, in every respect, the requirements of the German State Railways' specification for this class of material.

It should be noted that certain large flats 20 mm. (0.787 inch) thick, gave an apparent elastic limit not less than 36.2 kgr. per mm² (22.98 English tons per square inch) with a breaking strength of 55.5 kgr. per mm² (35.24 English tons per square inch).

As regards working the material, i. e., drilling, shearing, and planing, it was found that the silicon steel did not need any greater power than that taken to work ordinary steel.

The workmen even stated this steel was easier to drill than the ordinary steel.

Riveting also, did not call for any special precautions,

Joints difficult to get at, and which might have caused difficulties in maintenance, were welded. It was found that electric welding could be done quite normally.

This silicon steel was the first supplied by the Wendel steel works. This shows there is no special difficulty in making it and that it can be used generally, in structures above a certain size.

There is a tendency for its use to become more general.

The U. S. S. R. intend to prescribe the use of this new material in the near future in the construction of several important rail and road bridges, on the Dnieper.

The Chinese railways also have copied their example and the Americans are now also beginning to recognize that silicon steel is the best material to use in the construction of large bridges.

R. D.

[624 (0 & 669 .1]

2. - High tonnage steel in modern bridges.

The American review Engineering News-Record in its number of the 26 January 1928 devotes an article, over the signature of Mr. L. S. Moisseff, to the use of high tonnage steel in the construction of modern bridges.

In up to date construction work, a bridge has ceased to be an inert mass, but has come to be considered as a system of forces in equilibrium materialised in stone, wood, or metal. The tendency, continues to extend to make the materials work under the highest possible stresses and to increase this maximum by improving the materials. This tendency is especially marked (as it is also more necessary) in large structures in which the dead weight of the structure is particularly important in comparison with the useful live loads (for example, in the Hudson bridge, the proportion of the useful load to the dead weight is as I to 5).

In America in recent years, different special steels have been used and some particulars will be given of them below.

Nickel steel. — This steel was first used in 1920 in the Queensboro bridge — New York City — for the eye bars. Its characteristics were:

Elastic limit : 48 000 lb. on bars 16×2 inches.

Breaking strength: 85 000 lb. with 9 % elongation on 18 feet and a reduction of area of 40 %.

6 000 tons of nickel steel out of a total weight of 53 000 tons were used.

In the Manhattan suspension bridge, the stiffening trusses were also made of nickel steel.

In the Quebec bridge 16 300 tons of nickel steel were used, out of a total of 66 500 tons.

More recently, the stiffening trusses of the bridge over the Delaware at Philadelphia were made of nickel steel.

In 1915 use was made in the construction of the Harahan bridge at Memphis (Tennessee) of a steel known as « Mayari Steel » — a nickel chrome steel, made from a special ore from Cuba.

The tests gave an elastic limit of 55 000 lb,—per square inch, and a breaking strength of 85 000 to 100 000 lb.

Silicon steel. — This steel was used for the first time in 1915 in the construction of the Metropolis bridge over the Ohio. The characteristics specified were:

Elastic limit: 45 000 lb.:

Breaking strength: 80 000 to 100 000 lb.;

Elongation: 17 %;

Reduction of area: 35 %.

Silicon steel was again used in the Cincin-

nati bridge in 1917 and more recently still in bridges over the Delaware and the Carquinez.

The increase in price of this steel over ordinary steel does not exceed one cent per pound.

Special carbon steel. — Two kinds of special carbon steels are in use in America having the following characteristics:

Breaking strength, lb. per square	1	2
inch	105 000	80 000
square inch	73 000	50 000
Elongation in 18 feet, per cent.	5	` 8

Quality No. 2 has been used recently in the construction of the suspension bridges of the Carquinez Straits and of Florianopolis.

Steel wire. — Since White and Hazzard in America and Seguin in France built the first cable suspension bridges, steel wire has been used for this purpose on a large scale. Ever since the Brooklyn bridge was built, endeavours have been made to increase its elastic limit and its breaking strength.

The table below shows the progress-made in this direction.

Brooklyn	(1880)	:	160	000	lb.	per	square	inch.
Williamsburg	(1900):	:	20 0	000	lb.		_	
Manhattan	(1906):		210	000	lb.			
Delaware	(1923):	or	215	000	lb.			
Hudson	(1927):	4	220	000	lb.			

Up to the present no definite knowledge as to whether these steels will retain their values in service, is available.

Rivet steel. — Nickel steel has also been used for rivets with favourable results.

R. D.

NEW BOOKS AND PUBLICATIONS

[624.51 (01 (.73)]

FOWLER (CHARLES EVAN), Consulting Engineer. — The Detroit Windsor Bridge over the Detroit River. — A pamphlet (8 1/2 × 11 inches) of 26 pages with many figures. — 1928, New York City, 25, Church Street. (Price: 1 dollar.)

The interesting details given below have been taken from a pamphlet written by Mr. Charles Evan Fowler, Consulting Engineer, of New York, on the Detroit Suspension Bridge.

Clear height to be given by the bridge.

— This height should be great enough to allow ocean going boats coming up the St. Lawrence to pass under.

In the case of one of the steamers considered, the *Montauk* of 10 000 tons, the maximum height of the mast is 112 feet.

The American Radio Company consider that when equipping ordinary ships with 2-kw. wireless sets, 50-foot masts are needed: with 5-kw. sets, the maximum height required is 100 feet.

 $Opening ext{ of the suspended span: } 1\,850$ feet.

Comparison of the projected designs.

Various proposed designs were compared: wire cable or eye bar suspension bridges, cantilever bridges, and arch bridges of the Hellgate bridge type.

In the end, the wire cable suspension bridge was selected as being easier to build and cheaper.

Decking. — Two decks, an upper and a lower, were provided. The lower deck carries four standard gauge lines of railway operated by electric traction. The upper deck carries two tramway tracks in the centre and two 28-foot roadways, one on each side accommodating six lanes of automobile traffic. Two outside footpaths for pedestrians have also been provided. The width of 28 feet is considered ample to provide for three lanes of automobile traffic.

Live load capacity.

Congested live load.

Footpaths	i e Grana	2 of 7	feet at 100 lb. per square foot =	1 400 lb.
			- at 100 lb =	
Tramways		2 track	s at 2500 lb. per lineal foot =	5 000 lb
			at 6 000 lb = 2	
			Total ner lineal foot	

Normal live load.

Footpaths 2	of 7 feet at 50 lb. per square foot =	700 lb.
Roadways 2	of 28 — at 50 lb. — — =	2 800 lb.
Tramways 2	tracks at 1 000 lb. per lineal foot =	2 000 lb.
Railways 4	— at 75 % of 6 000 lb =	18 000 lb.
	Total ner lineal foot	

In fact, the maximum loads which may be experienced can be considered as

being the following: 50 lb. per square foot at most for the foot paths.

The Williamsburg bridge shows that the loading by automobiles rarely exceeds 42 lb. per square foot on very long spans. The load of tramways per lineal foot is very unlikely to exceed 100 lb. and for railways the load of 6 000 lb. given is undoubtedly much higher than any actual load.

In calculating the decks the live loads taken into account are given below, care being taken to take into account an impact co-efficient calculated for a speed of 20 miles an hour.

Footpaths: 100 lb. per square foot; Roadways: 20-t. lorry + 25 % impact;

Tramways : 50-t. coach $+\frac{150}{L+300}$ impact;

Railways: Type E 60 train $+\frac{150}{L+300}$ impact.

Obviously temperature, wind, etc. allowances have to be added.

Unit stresses to be permitted.

1° Dead load + average live load + temperature or dead load + temperature + wind.

Tension:

Cable wire: 85 000 lb. per square inch; Suspender wire: 40 000 lb. per square inch; Alloy steel: 30 000 lb. per square inch; Structural steel: 20 000 per square inch.

Compression:

Alloy steel : 30 000 - 120 $\frac{l}{r}$:

Structural steel: $20\ 000 - 80\frac{l}{r}$

2. Dead load + congested live load + temperature or dead load + normal live load + temperature + wind.

Tension:

Cable wire: 100 000 lb. per square inch; Suspender wire: 50 000 lb. per square inch; Alloy steel: 45 000 lb. per square inch; Structural steel: 20 000 lb. per square inch.

Compression:

Alloy-steel · 45 000 — $150\frac{l}{r}$:

Structural steel: $20\ 000 - 80\frac{l}{r}$.

Unit stress tower posts:

Alloy steel in compression : $35\,000 - 140\frac{l}{r}$

Steel specifications.

Ordinary grades of steel could not be employed for a structure of such size, and investigations were made in America and elsewhere for special grades of steel suitable for the purpose.

The steel wire used in the Manhattan bridge had an ultimate strength of 215 000 lb. per square inch and an elastic limit of 68 % thereof. For the Detroit bridge a wire of 230 000 lb. ultimate strength with an elastic limit exceeding 75 % of this value was needed.

The chemical composition of the wire used in the Manhattan, Williamsburg, Philadelphia and Detroit bridges and those proposed by the author are given in the following table.

	C	Mn	Si	Р	s	Cu
Williamsburg	0.85	0.50	0.10	0.04	0.03	0.02
Manhattan	0.85	0.55	0.20	0.04	0.035	0.02
Philadelphia	0.85	0.60	0.24	0.04	0.04	0.04
Detroit	0.85	0.60	0.24	0.04	0.04	0.04
Fowler	0.85	0.60	0.25	0.045	0.05	0.03

The minimum elongation required for the Manhattan bridge was 2 % on 12 inches before galvanising and 4 % after; for the Williamsburg, 2 1/2 % on 5 inches and 3 % on 8 inches; for the Philadelphia, 4 % on 10 inches; and the Detroit-Windsor and Fowler, 4 % on 10 inches.

The wire submitted by an English firm of the chemical composition specified for the Detroit bridge, would allow a working stress of 130 000 lb. per square inch as it showed the following results on testing, in lb. per square inch:

Test.	Area.	Yield point.	Ultimate strength.	Elongation.	Reduction of area.	
S 572 S 573	0.0281	190 400 192 192	231 392 229 600	4.2 5	45.2 45.2	

The various long span bridges recently built in America have used either nickel steel, or else silicon steel, this latter being only ordinary carbon steel with the addition of silicon. The composition of the silicon steel was C 40, Mn 1.00, Si 0.45, P 0.04, S 0.05.

The actual mechanical tests of this steel gave an elastic limit of close to 30 000 lb. on an average so that only a slight change is necessary to produce an alloy silicon steel with the required elastic limit of 55 000 lb. per square inch.

The breaking strength by the addition of silicon can be calculated either by Hadfield's formula (Journal of the Iron and Steel Institute) by Yensen's formula (Bulletin No. 83, University of Illinois) or by Carnegie's formula.

Breaking strength:

$$39\ 000\ +\ 950\ C\ +\ 1\ 050\ P\ +\ 85\ Mn \\ +\ 140\ Si.$$

Using this formula on a steel described by Hibbard in « Alloy Steel » which gave an ultimate strength of 113 760 lb. per square inch and an elastic limit of 74 000 for a chemical composition of

C 0.40, Mn 0.45, Si 1.40, P 0.04, S 0.05,

we obtain a close check of 112 225 lb. per square inch.

Applying this formula to a steel with a chemical composition, as recommend-

ed to the author by an eminent metallurgist

C 0.60, Mn 1.00, Si 0.45, P 0.04, S 0.05,

we get an ultimate strength of 115 000 lb. per square inch and an elastic limit of 57 500, characteristic of a high carbon silicon steel.

A silicon steel of the composition recommended by the author C 0.50, Mn 1.00, Si 1.00, P 0.04, S 0.05 would give a breaking strength of 113 200 lb. per square inch and at only 50 % an elastic limit of 56 600 lb. We may therefore conclude that a steel having a composition of C. 0.55, Mn 1.00, Si 0.55, P. 0.04 S 0.05 giving an ultimate strength of 110 650 lb. per square inch and 55 000 lb. elastic limit would be sufficient for the present bridge.

Tower design.

After comparison with the fixed towers of the Manhattan bridge, it was decided to use hinged towers. The stresses after calculation were checked from a paper model in accordance with Beggs' method.

The base and hinge castings are of cast steel, the largest section weighing less than 20 tons, each base covering an area of 22×25 feet producing a pressure of only 510 lb. per square inch on

the masonry. The hinge rollers are formed of 16 segmental rollers 24 inches in diameter.

Cable design.

The fundamental idea was to give the cables the same diametre: 21 3/4 inches as those of the Manhattan cables which is believed to be the maximum practical size and would reduce the time required for stringing the cables by half.

The sag adopted: 1/10th of the span; Diametre of the galvanised wires: 0.192 inches as used for the Manhattan and Williamsburg bridges.

The eight cables have nineteen strands each, the four upper cables being 21 inches in diametre with 420 wires per

strand and 7 980 wires per cable. The two inside lower cables are of the same size but the two outside are 18 inches in diametre with 300 wires to each strand and 5 700 wires to a cable.

The average variation in the sag of the cables due to temperature will be 2.97 feet and due to full live load 8.84 feet.

Stiffening trusses.

The bridge having been built with a single deck (the railway deck having been added subsequently) the stiffening trusses having no dead load stresses they will also be strengthened subsequently to take their full proportion of live load stresses of the deck carrying the standard gauge railways.

R. D.

[621 .51 (.44)]

LA HOUILLE BLANCHE. — L'Électrification du Chemin de fer du Mili et l'essor économique de la région du Sud-Ouest. (WATER POWER. — The electrification of the Midi Railway and the economic development of the South-Western District). — Special publicity number, published by Le Sud-Ouest Économique. — One volume 8° (10 1/2 × 9 inches) of 368 pages with many illustrations. — 1928. Bordeaux, Le Sud-Ouest économique, 6, place Saint-Christoly. — Price: 25 francs.

The Midi Railway is the French railway, on which the work of electrification is the most advanced. It is also the one on which the plans which have been prepared provide for the greatest proportion of electrified line. These circumstances are the result of its geographical position. As its distinguished director, Mr. Paul, writes, the railway has developed all along the chain of the Pyrenees over a district 180 to 200 km. (110 to 125 miles) in width and is therefore particularly well placed at all points, having regard to the possibilities of carrying current to long distance, to get supplies produced by power stations generating current from the water falls in the Pyrenees.

The electrification will exercise a large

influence on the economic position of the whole of the South. In addition to the benefits the Company will get from it and the greater facilities given the public, it must be considered that the plant for generating and transporting electric energy has not only taken the railway requirements into account, but includes a wide distribution system, making electricity available for other users. The undertaking having been designed on lines whereby electrical energy will be widely distributed, cannot fail to help the development of existing industries and even to induce the introduction of new ones. The very carrying out of the work of all kinds involved in the conversion to electric traction of so many lines, has caused a new activity in the

areas concerned. It is consequently understandable that the Sud-Ouest Economique should have thought of making the Electrification of the Midi Railway the subject of a special number. This number is well presented and fully illustrated, and is also instructive reading for an engineer.

The number opens with an interview with Mr. André Tardieu, in which the Minister for Public Works broadly outlines the programme of electrification of the French railways and shows the essential advantages thereof.

Mr. Paul then, in a noteworthy sketch, points out the magnitude of the work undertaken by the Midi Company, gives particulars of the results already obtained, and indicates what remains to be done to complete the work and to obtain the fruit therefrom.

The various plant is described by the Engineers of the Company responsible for the design and the carrying out of the work in a series of very interesting notes in which all the essential technical data are to be found. To quote them in order, they are: The large power stations of the Midi Railway Gompany, by Mr. Godard, Engineer in chief of the Bridges and Roads Service, Engineer in chief for the construction of new lines and Hydro-electric power stations; The Distribution of Electric Energy, by Mr. A. Bachellery, Chief Engineer of Rolling Stock and Locomotive Operation; Trans-

formers and Sub Stations, by Mr. J. Villeneuve, Assistant Chief Engineer for the technical services in the Chief Mechanical Engineer's department; The Rolling Stock, by Mr. P. Leboucher, Chief Engineer, Technical Services in the Chief Mechanical Engineer's department.

The first part also contains a note by Mr. Garan, Engineer in Chief of the Bridges and Roads Service, Chief Engineer for the Construction of new lines, who discusses the question of the Transpyrenean lines, a note by Mr. Henri Martin, who describes the most noteworthy works on the Aix-les-Thermes to Latour-de-Carol line, and a series of notices showing the development and the field of activity of the great industrial undertakings who have taken part in the Electrification of the Midi Railway.

In the second part, the reader will find information on the local industries which are expected to benefit by having electric energy at their disposal.

The third part brings out the wonderful future for the tourist industry in the South and calls attention to the marvels of nature in the region of the Pyrenees. Amongst these we will call attention to a note on the Role of the Railway Companies and in particular of that of the Midi, in the efforts of France to encourage touring, by Mr. J. Arnouil, General Inspector of Touring services of the Company.

E. M.

SACHS (KARL), Doctor of Engineering, Engineer of the Brown Boveri Co., Baden (Switzerland).

— Elektrische Vollbahn-lokomotiven (Railway Electric Locomotives). — One volume 40 (8 × 10 1/2 inches) of 461 pages with 448 illustrations in the text and 22 folded plates. — 1928, Julius Springer, Publisher, 23-24 Linkstrasse, Berlin, W. 9. — Price bound: 84 Reichsmark.

Those interested in electric traction frequently find in the technical press articles on projected schemes or schemes in course of execution in various countries.

The reading of these articles, which

are sometimes general in their outline, but at the same time deal with one subject only, however interesting they may be, is not of much value unless the reader has a general knowledge of the subject. For this reason a book dealing with electric traction in a methodical manner, even if rather didactic, cannot fail to be of great use both to practising engineers and to those who wish to study the subject and thereby obtain knowledge of it.

The subject being of course very wide, any book would gain in interest and usefulness if it limited itself to a well defined part of the subject. The object of this book is to explain the electric locomotive, which is the heart of the electrification of a railway.

However important the fixed plant, the power stations, the distribution mains, the transformer stations, the contact lines may be, an electric locomotive, which is an engine both mechanical and electrical and which has given rise to many complicated questions, still remains the essential problem.

In the introduction, the author compares the steam and electric locomotives as regards their tractive effort and power.

The book is divided into four chapters as follows:

1st: Traction power, and horse power; 2nd: Mechanical equipment (the vehicle);

3rd: The electric equipment;

4th: Description of locomotives that have been built.

In the first chapter the methods and formulæ by which the tractive effort and the power to be developed can be calculated are described. The author goes on to describe the method of tracing the curves showing the various factors to be considered during the running of the train. He has set them out for the principal systems of electric locomotives.

The object of the second chapter is the one that has caused the greatest difficulty and necessitated the most investi-

gation. This problem is more a mechanical than an electric one whether it be either the building of the vehicle or devising a satisfactory arrangement of drive from the motors to the wheels. This latter can be done without the use of reduction gears, or with them, and the methods used again depend on the kind of current and the sort of motors used. The height of the motors has a great effect on the stability of the locomotive, and the theories developed for steam locomotives are applied in the book. same may be said of the method of connecting the main frame to the trucks and bogies, and the motor bogies together, and as regards the inscription of the locomotive on curves. All these points are gone into in detail. This second chapter also contains a complete description of the brake gear both vacuum and compressed air.

The third chapter (electric equipment) includes four parts: continuous current locomotives, monophase locomotives, three phase locomotives, and locomotives on which the current is transformed.

This chapter is a complete descriptive and theoretical treatise on the machines and appliances to be found on an electric locomotive. Each part is preceded by an historical introduction which makes it possible to appreciate the extent of the work already done by inventors and builders alike.

The fourth chapter gives a detailed description, with folded plates at the end of the book, of fifteen electric locomotives in service in various countries of the world.

The many bibliographical references in the book are indexed in a table, giving them in alphabetical order, under their authors' names.

E. M.

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